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ABSTRACT

This publication developed by the New York State Education Department with the cooperation of the University of the State of New York, is a curriculum guide for elementary science (grade 4-6). This guide is organized around 6 large subject areas: (1) Living things; (2) Our growing bodies; (3) Air, water and weather; (4) The earth and its composition; (5) The solar system; and (6) Matter and energy. It is also organized by grade level in each of the six major areas of study. Each such unit follows a sequential teaching pattern incorporating suggested activities for the teacher as well as for the pupil. The format is consistent through all grade levels and is organized as follows: (1) apparatus and materials; (2) purpose of the unit; (3) introduction of the unit; (4) experiences relating to the unit; (5) enrichment; (6) organization and use of information gained; (7) basic understandings; (8) vocabulary; and (9) scientists. A table that summarizes the organization of this elementary science program with suggested grade placement is also included. (Author/HM)

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SCIENCE FOR CHILDREN 4-6

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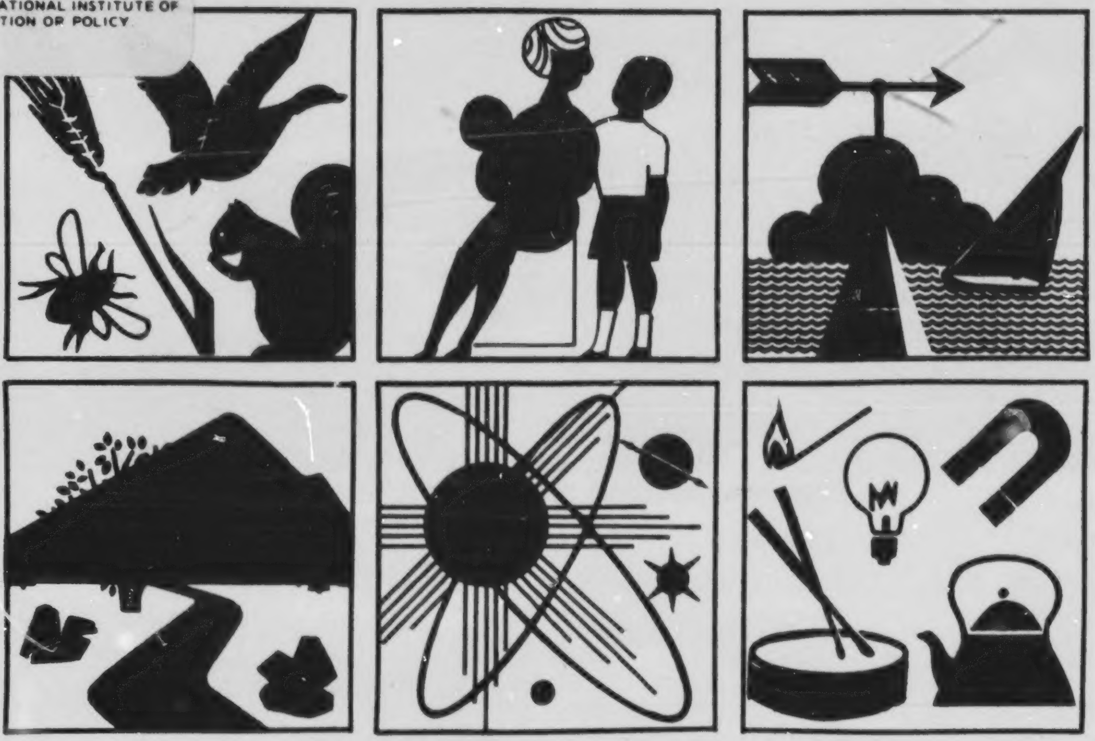

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of General Education Curriculum Development
Albany, New York

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SCIENCE FOR CHILDREN 4-6

1978 Reprint

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
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FOREWORD

Educators who are concerned with the planning of a program for today's elementary schools accept the responsibility of making science a part of the total program. They appreciate the significant impact of scientific development upon the life of everyone. They realize that science education must be included in every program which seeks the best possible development of our children in preparing them for effective living in a world of rapid change — a world of electronics, of nuclear energy, and of startling biological advances.

Children in their formative years must be started along avenues toward acquiring an appreciation of truth and intellectual honesty, as well as toward developing a talent for objective and critical thinking. Such routes may well lie in the area of science where there exists an especially rich source of educational experiences. Many types of activities, such as discussing, reading, manipulating, collecting, and experimenting, contribute to the growth of children and will be useful to them as they develop into informed and productive citizens.

This publication is being reprinted at this time to accommodate the demands for curriculum materials for elementary school science. Schools will continue to find these materials helpful in structuring their elementary science programs.

The Department is currently involved in working on a major revision of the science program for the elementary schools. This project will be extended over the next two years. In the meantime, *Science for Children 4-6* will continue to provide sound materials for continuing quality science programing.

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a LIVING THINGS

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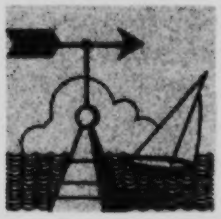
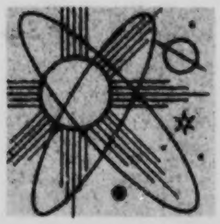


c AIR, WATER, AND WEATHER

d THE EARTH AND ITS COMPOSITION



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INTRODUCTION

The format incorporated in this handbook represents a substantial departure from previous publications produced by the Department. For this reason, the reader is urged to read this introduction carefully in order to acquaint himself with the design, purpose, and intent of this organization.

Areas of study

Science for Children has been organized around six large subject areas:

a LIVING THINGS
b OUR GROWING BODIES
c AIR, WATER, AND WEATHER
d THE EARTH AND ITS COMPOSITION
e THE SOLAR SYSTEM AND BEYOND
f MATTER AND ENERGY

All of these areas overlap and are interrelated with no clear division between them. There is no intent on the part of this handbook to imply that all of science is composed of six basic areas, and the teacher is cautioned not to give our children such an impression. This division is simply one of many possible ways of organizing the content of science for efficient teaching and learning in the elementary school.

The teacher should constantly point out the common threads which cut across all areas of science. The subject should not be presented as a number of seemingly unrelated topics. Unless these unifying themes are made evident, the science program will develop into a patchwork of various topics rather than a woven pattern with a basic and continuing design. For example, the production and transfer of heat energy plays a major role in our own life processes, our personal health, the weather around us, the geological structure of the earth, the composition of distant stars, and the operation of everyday machines.

General format

This handbook is organized by grade level in each of the six major areas of study. Each such unit follows a sequential teaching pattern incorporating suggested activities for the teacher as well as the pupil. The format is consistent through all grade levels and is organized as follows:

- PURPOSE OF THE UNIT
- INTRODUCTION OF THE UNIT
  - *Motivating activities*
  - *Motivating questions*
- EXPERIENCES RELATING TO THE UNIT
- ENRICHMENT
  - *Questions to stimulate further thought*
  - *Topics for additional exploration*
- ORGANIZATION AND USE OF INFORMATION GAINED
  - *Projects*
  - *Questions to guide a summary of experiences*
- BASIC UNDERSTANDINGS TO BE GAINED
- VOCABULARY
- SCIENTISTS

Before using the material in this handbook the reader should be aware of three points:

1. *Under no circumstances should a teacher attempt to use all the activities listed in any unit. The material herein presented should be regarded as a reservoir of ideas and from these a program should be developed. Because of the diversity in our schools and local communities, no singly designed program could possibly be ideal for all schools. Therefore, the selections in this publication are many and varied in order to provide an adequate resource for all schools.*

2. *The grade-level placement of activities and their arrangement within the unit are only suggested and are not to be interpreted as mandatory. It is possible, for example, that the enrichment material suggested for one grade may be used as motivating experiences for a later grade.*

3. *The wide range in subject matter incorporated in this publication should make it acceptable as a companion to any series of science textbooks. If a school wishes to build its science program around the design of a particular series of texts, it may find appropriate activities in this handbook to augment the text-centered course. On the other hand, the general outline of this publication may serve as the core of a science program with many science books used for supplementary reading and exploration.*

Explanation of format

APPARATUS AND MATERIALS. A list of apparatus and supplies precedes each unit. This list includes the materials which would be needed in order to perform all the activities described in the unit. Items such as paper, pencils, scissors, crayons, tape, and so on have been assumed to be readily available and therefore are not included in these lists.

PURPOSE OF THE UNIT. Each unit in this handbook has been developed around a single principle or purpose. The initial statement which appears at the beginning of the unit is directed to the teacher for his own orientation and is not suggested as an introductory statement for the pupil. It is strongly suggested that the reader look over the list of " basic understandings to be gained " located toward the end of each unit in order to better understand the purpose stated at its beginning.

INTRODUCTION OF THE UNIT. It is generally agreed that learning proceeds most effectively when the learner is interested in, and motivated toward, the subject at hand. For this reason, a number of motivating activities and motivating questions have been included in each unit of this handbook. These activities and questions should be presented in an open-ended fashion so that they will lead to further questioning rather than to " an answer."

EXPERIENCES RELATING TO THE UNIT. A substantial portion of science education should involve direct experiences on the part of the learner. Touching, manipulating, testing, and experimenting are useful and effective avenues for learning. Many activities can and should be undertaken by children. Some, however, are better performed as demonstrations by the teacher. Teacher demonstrations are especially in order when safety becomes a factor. Young children should not handle very sharp tools, explosive or corrosive chemicals, or electrical apparatus other than battery operated. The teacher may also find it best to perform demonstrations for his class if costly apparatus is involved so that breakage will not become a problem. In addition, very young children may not have developed sufficient coordination to make the necessary fine adjustments for a particular laboratory setup. At such times, the teacher should let the children observe rather than perform.

However, when safety is not a factor and equipment is neither extremely costly nor complex, every possible effort should be made to allow the individual pupil to carry out his own science experiences.

Field work is included within the collection of *Experiences Relating to the Unit*. The term field work includes any learning experience which takes place beyond the walls of the regular classroom. Besides trips to the woods, parks, and playgrounds, visits to various areas within the school building are also suggested.

Field trips to specific places may be repeated one or two times during the child's elementary school experience to emphasize different understandings. For example, a trip to a zoo may be used with kindergarten children to point out the variety of animals. First-grade children may visit a zoo to observe how animals move about. The zoo provides an excellent place for second-grade children to learn about the food habits of various animals.

ENRICHMENT. Because individual differences exist among pupils in their general ability and interests, suggestions for enrichment have been incorporated in each unit. Some children will have the ability and desire to explore beyond the normal classroom work. The suggestions for enrichment may be given to individual pupils or an entire class may pursue one of these additional topics.

ORGANIZATION AND USE OF INFORMATION GAINED. Both projects and questions are suggested in this section for tying together and reviewing the various activities undertaken during the study of the unit.

BASIC UNDERSTANDINGS TO BE GAINED FROM THE UNIT. These statements summarize the concepts which should be developed through the activities included in the unit. These basic understandings relate directly to the introductory statement given as the *Purpose of the Unit*.

VOCABULARY. The vocabulary list comprises the words which pertain to the unit and which should be familiar to the children at each grade level. Young children should be able to incorporate these words in their speaking vocabulary while the teacher may wish to incorporate these words in the spelling lists of older children. Some very interesting work can be initiated by studying the derivation of many scientific words through stems, roots, and historic origins.

SCIENTISTS. At the end of each unit is a list of men and women who have played a major role in the scientific work relating to the general topic of the unit. Biographical studies will substantially add to the appreciation and understanding of the unit's work.

Future revision

The reader is invited to submit his most successful and effective science activities to the Bureau of Elementary Curriculum Development so that they may be considered for inclusion in future editions of this handbook. In this way the elementary science program across the State may continually improve. Any activities which are submitted will be carefully read and whenever fitting will be incorporated as revisions are made.

Fourth Grade

- a LIVING THINGS
- b OUR GROWING BODIES
- c AIR, WATER, AND WEATHER
- d THE EARTH AND ITS COMPOSITION
- e THE SOLAR SYSTEM AND BEYOND
- f MATTER AND ENERGY

Fourth Grade

a LIVING THINGS

PART 1

Plant Reproduction

PURPOSE OF THE UNIT: ***to learn the different ways by which plants may be reproduced***

Apparatus and materials

1. Corks
2. Bowl, glass
3. Bulbs, flowering
4. Fungi
5. Hand lens
6. Jar, screw top
7. Lima beans (seed)
8. Model, flower
9. Mucilage
10. Needles
11. Pans, shallow
12. Paper, blotting
13. Pea pods
14. Plant cuttings
15. Potatoes
16. Potted plants (geranium, coleus)
17. Seeds (apple, radish)
18. Tumblers, water

INTRODUCTION OF THE UNIT

Motivating activities

1
Make a display which shows various methods of growing new plants from seeds, bulbs, graftings, spores, cuttings, and runners.

2
Arrange a collection of seeds showing variations in size. Some easily obtained seeds are coconut, avocado, chestnut, peach, acorn, cherry, apple, and radish. Can the children identify the seeds displayed?

3
Display a collection of plants showing different varieties. Include household plants, such as African violets, coleus, begonias, geraniums, cacti, and vines. Pot some garden plants, such as tulips, daffodils, or chrysanthemums. Young potted azaleas, holly, or other ornamentals will add interest to the exhibit.

4
Select an unusual plant for a "What Is It?" display (snake plant, pineapple plant, etc.). Provide literature so that children can look up the answer. Place a ballot box for the children's answers next to the display.

5
Display some colored pictures of flowers showing close-ups of individual plants and flower parts.

6
Exhibit pictures of wildflowers growing in fields, along roadsides, in woods, and along stream and swamp borders. Ask children "How do these plants get here?", "Why do these plants grow here?", "Do you see any garden flowers?", "Why not?", and "Do the same plants grow in wet areas that grow along roadsides?"

7
Plan a bulletin board displaying pictures of a variety of garden, house, and wild plants which may be familiar to the children. Make a caption for the display: "How many of these do you know?"

Motivating questions

1. Where do new plants come from?
2. Where do seeds come from?
3. How do seeds travel from place to place?
4. What would happen if all the plants in the world died today?
5. What are the biggest plants in the world? (Kelp, redwoods.)
6. Name all the plants you know that grow from bulbs. Does the bulb live from year to year? What bulbs do you eat? Do plants having bulbs produce seeds? Why do you think daffodils, hyacinths, and other plants having bulbs can blossom so early in spring?
7. What is a perennial plant? An annual plant? A biennial plant?
8. What whole seeds do you eat? What foods are made from seeds?
9. Why won't seeds grow inside you if you eat them?
10. Do all plants have seeds?
11. What kinds of creatures eat the seeds of wild plants? Do they help or hinder us when they eat these seeds?
12. What animals eat seeds or other parts of plants that man wants for himself?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
Using a large chart or model, show the main parts of a flower. Point out that the purpose of a flower is to produce seeds, and most plants we see around us have flowers.

2
Discuss seeds that are scattered by a mechanical device. The witchhazel, a woody shrub or a small tree, demonstrates this means of seed dispersal very well. When temperature conditions are right, the seed container dries and the seeds are slowly squeezed until they pop out. Sometimes the tiny football-shaped seeds are popped for a distance of several feet. Branches bearing unopened fruits can be collected in the fall, when the yellow strap-shaped flowers are in bloom. Keep these in a warm classroom; the children will see and hear the witchhazel pop its seeds.

3
Demonstrate the techniques for potting and transplanting plants.

4
Show the children how to start plants from cuttings (slips).

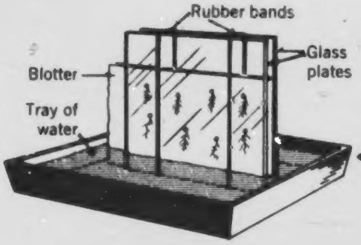
5
Lower plants, such as ferns, mushrooms, and molds, reproduce by means of spores. Use charts and/or pictures to illustrate the location of spores on the plants. Point out that simple plants such as these do not have flowers, therefore, they cannot produce seeds. Some of these plants produce millions of spores.

6
Color films and filmstrips are available which show the various reproductive methods of plants. Some excellent movies have been produced showing plant growth from seeds through time lapse photography.

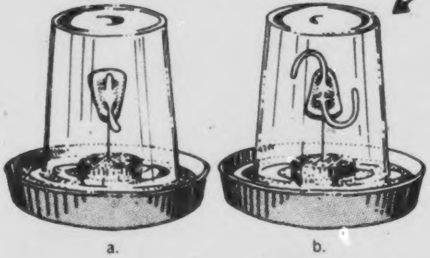
Activities for children

1
Have children open a pea pod and find the peas.

2
Soak some large, dried, lima beans in water overnight. Have the children remove the seed covering, split apart the stored food (cotyledons), and discover the baby plant.



3
Children can watch germinating seeds and observe that roots grow downwards; shoots grow upwards. The general growth rates can also be noted. See illustration at left. Radish seeds serve very well for this demonstration. It may be desirable for a child to use a few different kinds of seeds for comparison purposes, or each glass garden may hold a single crop.



Germinate kernels of corn in the manner described in the previous activity. Just after they begin to sprout, remove them from the germinator. Place the eye of a needle in a cork and place the corn on the point of the needle, with the root tip pointing up. Cover the bottom of a saucer with a blotter and place the cork on the blotter. Cover with a glass tumbler and keep the blotter wet. Observe the corn grain from day to day. In which direction does the root grow?

Note: Seeds for germination demonstrations can be obtained in small packets from seed and hardware store. Canned or frozen seeds (beans, peas, etc.) will not germinate.

4
Seeds which have been germinated on blotting paper can be studied with a hand lens. The root system is amazingly intricate. These tiny roots can best be seen if the blotting paper liner is a dark color.

5
In the classroom, cut an onion bulb crosswise. Notice the layers of which it is made. These layers are really leaves thickened with stored food. How does the plant make use of this stored food?

Cut another onion lengthwise. See the bud in the center. Is there more than one? This bud would grow up through the leaves at the top of a long stem. Tulip, iris, and daffodil grow the same way.

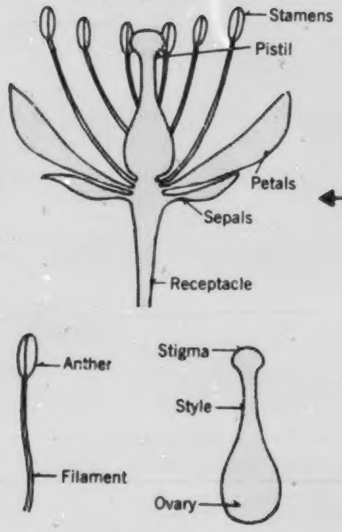
Find an onion a little larger than a tumbler. Fill the tumbler with water and place the onion in the top of the tumbler. Watch it carefully. Hyacinth bulbs may be grown in a similar manner. Do roots or leaves start first? Why?

6
Plants can be grown from cuttings. The class can be divided into a number of small groups; each group can start a few cuttings of a particular plant. Some plants that may be successfully used are:

Violet (leaf) Coleus (branch) Philodendron (stem) Geranium (leaf)
Begonia (leaf) Pussy willow (twig) Willow tree (twig)

Place the cuttings in water. Use glass jars so children can observe root growth. Record how long it takes for roots to grow. When the slips have formed roots, remove them from the water and plant them in pots filled with garden soil. For the first week, the cuttings should be kept from direct sunlight. They may be used for classroom decorations, or the children may take them home. Cuttings can also be started in moist sand.

7
Observe spores on bread mold with a hand lens. Rub a half slice of bread slightly on a desk top or the floor. Place this bread in a screw-top jar in which there was previously placed a wet blotter or a moist paper towel. Screw on the jar top and place the jar in a warm, dark place. Observe growth with a hand lens from time to time.



8
Dissect a tulip, lily, or gladiolus to study its parts. Rub an anther over a piece of black paper to see traces of pollen. Cut the ovary open with a knife and find the ovules or seed packets. Identify the parts of the plant. Remove the petals and sepals; find the stamens, pistil, filament, and anther. Discuss the functions of each part.

9
Start a bulb for a Mother's Day gift. Discarded plastic household detergent containers, with tops cut off, make very attractive vases.

10
Bring two or three potatoes to school and keep them in a dark place until sprouts appear. From what part of the potato do the sprouts come? Leave the sprouting potato in the light. What changes take place? A potato is a tuber. It is a kind of stem thickened with stored food. After planting, of what use is the old potato tuber to the young plant?

11
Collect some seeds and group them according to how they travel. Seeds carried by air may have tiny tufts which resemble parachutes (dandelion, thistle, willow, cottonwood, milkweed, cattail). Others may have winged seeds, such as the maples, elm, ash, tree of heaven, and most cone-bearing trees. Grass seed is very light and may be scattered by the wind. Seeds which are spread by animals may be separated into two categories: those that are eaten and those that stick to clothing and fur. The fall is a good time to collect hitch-hiking seeds. These may have tiny barbed prongs, hooks, or fuzz, which stick to the fur or

clothing of wanderers afield. Examine these seeds under a hand lens to see what makes them stick. Seeds in some berries and fruits which are eaten by animals pass through the digestive tract and are eliminated in their droppings.

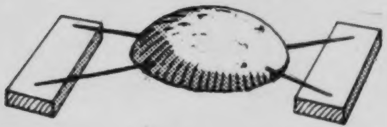
Animals that store food are seed spreaders. Squirrels, chipmunks, and mice hoard many kinds of seeds. Those that are not eaten may germinate if enough moisture reaches them. Beech seeds, acorns, hickory nuts, walnuts, and maple seeds are a few which may be planted by these rodents.

The witchhazel and the jewelweed (touch-me-not) are two good examples of plants that spread their seeds by a mechanical or explosive device.

One of the best examples of a waterborne seed is the coconut. Since it is one of the largest of all seeds it cannot be carried by wind or small animals. If it falls into water, it floats. It may travel many miles before it is washed ashore where the seed it contains may germinate.

12
Place rows of various seeds on a moistened sponge. Place the sponge in a covered plastic or glass dish. Use pumpkin, sunflower, radish, bean, grass, or other seeds. Observe the difference in the length of time for germination. Note the changes which take place as the germination progresses.

13
The spores from gilled fungi (mushrooms) can be collected and preserved in the form of a spore print. Gilled fungi may be recognized by the slits which radiate from the center to the edge underneath the cap. Mix equal amounts of paper mucilage and water together; spread a very thin coat over an area slightly larger than the diameter of the mushroom on a 6-inch square of light colored paper or thin cardboard. Cut off the stem of a well-developed, fully opened mushroom. The gills of some mushrooms may protrude below the cap and will fold over when placed flat on paper. Therefore, it is a good idea to raise the cap over the paper by sticking four toothpicks in the side of the mushroom cup and supporting these on small blocks of wood or on two erasers placed at opposite sides. Place the cap, gills down, over the middle of the paper on which the mixture of mucilage and water has been spread. Cover with an inverted glass bowl and leave undisturbed for 24 hours. The spores will fall from the gills and stick to the mucilage mixture. Remove the bowl, lift the cap off, and let the paper dry in the air. The print may then be preserved with a fixative of clear plastic spray if desired. Children may have to experiment with the colors of paper used to collect the spores because the spores vary in color from white to black. Light blue paper can be used since no mushroom spores are blue.



Note: The inky cap mushroom should not be used because the gills break up or melt into a black liquid. Caution the children not to taste the mushrooms, although some are edible, and very tasty, none should be eaten unless they can be positively identified as edible. Children should wash their hands thoroughly after they have handled mushrooms.

14
Bring a puffball to class. These may be found in the woods or fields during any season except winter. Cut open the puffball and see how easily the dusty brown spores are carried by the air. Collect some spores on a piece of white paper and examine them under a hand lens or a stereomicroscope. What do they look like? Why does the plant produce so many spores?

15
Arrange a bulletin board display of wildflowers. Such a display may serve the dual purposes of wildflower recognition and wildflower conservation. The flowers can be placed individually in test tubes, then held in position on the bulletin board by strips of oak tag placed over the tubes and stapled to the board. Masking or adhesive tape can also be used to hold the tubes in place.

Some spring wildflowers which may be selected are the white and red trillium, hepatica, blood root, mandrake, mayapple, trout lily and varieties of violets. Next to the flowers display color pictures of the plants. (Many schools have the color plates published by the New York State Museum from *Wildflowers of New York State.*) Emphasize the need for discriminate picking of wildflowers. Look up information about the life histories of common wildflowers such as the white trillium and the trout lily. Such studies will help to explain why it is necessary to curb our picking of some flowers more than others.

16
Plant diaries may be kept for flowering plants which are accessible for daily observations. Keep a record of a single plant from budding to fading.

Fieldwork

1
During the fall take trips afield to collect seeds from wild plants. Many of these will stick to the clothes as one walks through weedy fields. Take a hand lens with you to examine the seeds closely. Seeds can be taken back to the classroom to be planted or dried for use on the bird feeder.

2
Visit a tree nursery to see how young tree seeds are germinated. Find out about the source of the seeds. Note how the trees are transplanted. Ask about the special care necessary for some plants. Ask the caretaker about the uses of the trees. Find out the names of some of the trees.

3
Visit a greenhouse. Ask the owner to show and explain the variety of techniques used to start new plants. Find out about proper care of house plants. Perhaps you can get some hints for starting a classroom flower garden.

4
Visit a woody spot at different times to observe spring wildflowers. Make note of their habitat. Wildflowers can best be appreciated if observed in their natural habitat.

5
The spring of the year is a good time to visit an orchard. Find out how the owner increases the number of trees in the orchard. Ask why beehives are sometimes placed in the orchards. Observe the care given to the trees. Find out about insects or diseases of the tree that may destroy the fruit. How does the farmer combat these?

6
Take a walk around the building during the spring to collect tree seeds. Note the various shapes, sizes, and the means by which they are spread. Take some back to the classroom and plant them. Look for some seeds that have begun to germinate. Look for the remains of seeds that have been eaten by animals.

7
Plan a trip to look for fungi and ferns. Ferns are usually found in cool, damp places. In the spring you can look for the "fiddleheads" of the new fronds (leaves) as they begin to unfold. Fungi can be found growing on the trunks of living trees, decaying stumps, fallen branches, and on the school lawn. Look for a "fairy ring" of mushrooms. How are fairy rings caused?

8
Visit a museum to see the fossil ferns which have been preserved in rock.

ENRICHMENT

Questions to stimulate further thought

1. How is sugar cane raised from cuttings?
2. Plants which produce spores release hundreds of millions of these every year. Why is it that our earth is not covered by these plants?
3. Will seeds that have been frozen germinate?
4. How old can seeds be and still sprout?
5. Do water plants flower and produce seeds?
6. Why do some plants have many seeds while others have only a few?

Topics for additional exploration

1
Ancient plants. The horsetails (scouring rushes) and the clubmosses are interesting near relatives of the fern families. They are similar to those that thrived as large treelike plants during the prehistoric Carboniferous period.

2
Seeds of desert plants. Some seeds can survive for a very long period of time before they germinate. Seeds of desert plants may wait many years before beginning to grow. What will make them germinate?

3
Parasites and saprophytes. The fungi which obtain their food from living things are called parasites. The fungi that live upon dead things are called saprophytes.

4
The Indian pipe. The Indian pipe is an interesting plant which resembles a fungus plant in that it lacks green coloring matter. It derives its food from dead plant matter but, unlike the fungi, it bears true flowers and seeds.

5
Propagation by runners. Some plants, such as grasses, reproduce themselves by sending out runners through the soil just below the surface. Others grow by spreading out over the surface of the ground and eventually forming a mat.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Children can make flower calendars to take home to their parents. Include information such as planting and blooming time for flowers. The information can be found on seed packets or in catalogs. Use wildflower books for the blooming time of these plants. Some children may wish to prepare such a calendar for garden vegetables.

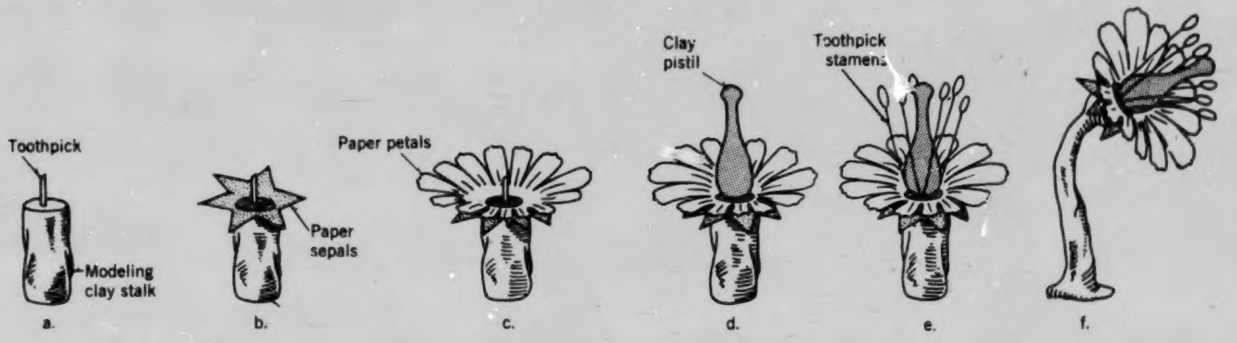
2
Look up information about the origin of food plants and locate these on a large map of the world. See *National Geographic Magazine,* August 1949, Vol. XCVI, No. 2, " Our Vegetable Travelers."

3
Make a large diagram of a seed and label the seed's parts.

4
Make a collection of fungi. If possible include a piece of the material on which the plant was found. Most fungi will keep for a long time in the classroom if they are dried.

5
Make a large chart of the parts of a flower.

6
Construct a large model of a flower from plastic clay or styrofoam. Colored construction paper can be used for the petals and sepals. Stamens can be made from toothpicks or pipe cleaners. Other parts of the flower may be distinguished by using various colors of clay.



7
Dissect the parts of a flower, mount them on a piece of heavy paper or cardboard, and label them. Fragile parts can be put in small envelopes of plastic wrap and attached to a background. Write a brief description of the function of each part of the flower.

8
List the common plants which are used as a source of food. Group these according to the part of the plant we eat.

9
Make an exhibit of pressed flowers.

10
Start growing garden plants indoors. Plants such as tomatoes can be started in paper cups. The containers should have holes punched in the bottom for drainage. The plants can be set out-of-doors at the proper time for a school garden, or they may be taken home and transplanted by the children for their own gardens.

11
Select a plot of ground near the school building for a flower garden. Children may be interested in enhancing the looks of the school building by planting flower borders along the walks or around the flagpole. Schools without a sufficient amount of space to grow flowers can plant window boxes. Plant some bulbs of the crocus, daffodil, narcissus, and tulip during September or October. Plan your garden to supplement these early bloomers so that you will have flowers in blossom from early spring to fall. Seed packages and catalogs will provide information about planting and blooming.

Questions to guide a summary of experiences

1. Why do plants have flowers?
2. Why are seeds necessary?
3. How do plants reproduce from parts other than seeds?
4. What conditions are necessary for a seed to start growing?
5. How is pollen transferred from the stamen (anther) to the pistil (stigma)?
6. How do seeds travel?
7. From what does the fruit of a plant develop?
8. What are nonflowering plants? How do they reproduce?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Living things are produced by similar living things.
2. Some plants grow from seeds.
3. Seeds are produced by flowers.
4. Fruit develops from the flower.
5. Seeds are distributed by explosion, wind, water, and animals.
6. Some plants produce bulbs or tubers while lower plants, such as molds, fungi, and ferns, reproduce by spores.
7. New plants can be grown from leaves or stems of other plants.

VOCABULARY

cutting
dispersal
embryo
fungi
grafting
mechanical
mold
mushroom
petals
pollen
pollination
reproduce
seed
slip
spores
tuber

SCIENTISTS

Burbank, Luther
Mendel, Gregor

Fourth Grade

a LIVING THINGS

PART 2
Animal Reproduction

PURPOSE OF THE UNIT: ***to learn the different ways by which animals reproduce themselves***

Apparatus and materials

1. Ant colony
2. Aquarium
3. Boxes, shoe
4. Coffee-can insect cages
5. Egg incubator
6. Eggs, animal
7. Eggs, frog
8. Hand lens
9. Kitten, or puppy
10. Medicine dropper
11. Mice, white rats, or hamsters (in appropriate cages)
12. Microprojector
13. Microscope
14. Scales, weight
15. Slides, microscopic animals
16. Spider, with appropriate container
17. Tapioca or rice kernels (uncooked)
18. Tent caterpillars
19. Test tubes
20. Thermometer

INTRODUCTION OF THE UNIT

Motivating activities

1
Show some pictures of baby animals. Can you tell from these pictures which animals receive care from their parents and which ones receive little or no care? Note that some resemble their parent animals more closely than others.

2
Use the " What Is It? " technique to arouse children's curiosity. Display one or more of the following: a spider egg case, a praying mantis egg case, a tent caterpillar egg mass, a part of a bird's egg or a bird's egg which has fallen from its nest, a turtle egg, a skate's egg case, the string of egg cases of the whelk, or some ant pupae.

3
Many grade level books are available which tell about the life cycle of animals. Read the children a story about a particular animal or groups of animals.

4
Show a filmstrip or movie that describes how animals differ in the care of their offspring.

Motivating questions

1. Do animals produce others of their kind? What are some examples?
2. What animals lay eggs?
3. Why are the young of many animals born in the spring?
4. What animals produce just one or two young at a time? Can you name some animals that produce hundreds of young at a time? Why is it necessary for some animals to produce so many young?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
If possible, arrange to have some young kittens or puppies brought into the classroom for a few hours. Do not allow the children to maul the young animals. Note the similarity to the parent animal. Can you see any differences? Are the eyes open?

2
If an incubator can be borrowed or built, hatch a fertile hen's egg obtained from a hatchery. Small individual incubators are advertised in many magazines and may be available in hobby stores. Make sure the chick is well fed and cared for. It should be given to someone who keeps chickens, when the class begins to lose interest.

3
Keep a few guppies in an aquarium. The males can be identified in that they are smaller and more colorful than the females. When a female is about to have young, place her in a separate container. Guppies, unlike many other fish, bear the young alive. The young will be eaten by the adults unless they are removed to another container.

4
Tent caterpillars are interesting to study in the classroom. Winter is the best time for collecting their egg masses, which look like inch-long, dark brown swellings on the twigs of wild cherry and apple trees. If you can collect these in winter and bring them into the classroom, the eggs will hatch before the leaves are out

on the trees. To provide food for the tiny caterpillars, bring in some cherry twigs and put them in water. The buds will open and the leaves come out. If you bring in fresh twigs each week beginning about the end of March, you will be sure to have food for the tiny caterpillars. Although these caterpillars are pests, they are very interesting to watch, especially in the making of their tents. Try putting a twig with an egg mass in a test tube of water; fastening the tube to the classroom wall. Next to it, in another test tube, keep a twig with leaves on it (one that you have been "forcing"). When the larvae hatch, they will move around until they find the food. When the leaves on the first twigs are gone, put up another twig a few inches away. In this manner, you can get the caterpillars to move several feet away for their daily diet of leaves.

Each night, the caterpillars will return to their original twig, or to one that they were feeding on earlier, and they may build a tent there that the class can see. Look for the tiny silken threads by which they guide themselves across the wall to and from their feeding grounds.

Destroy these, and the caterpillars become very upset. Without their silky highways, travel is erratic and slow.

5
Prepared slides of microscopic animals can be obtained from biological supply houses or may be borrowed from the high school biology teacher. The use of a microprojector will allow a better class discussion of these slides than having the children take turns looking through a microscope. Obtain some slides which illustrate the simplest method of animal reproduction, by splitting apart (binary fission).

Children will be amazed at the amount of life in a drop of pond water. Obtain some water and plant material from a fresh water source such as a pond, marsh, or ditch. Your aquarium may supply some of these microscopic animals. Use a medicine dropper to remove some water from around the plant material in the container, since protozoa (microanimals) often feed near plants. Place a drop of this water on a microscopic slide and cover it with a cover slip. The drop should be just large enough to cover the area under the cover slip. Place the slide on the microprojector stage and project it on a screen or a white surface. It is probable that paramecia, amoeba, vorticella, and other microorganisms will be present. A single protozoa may be seen splitting in two, forming two new organisms. Look up pictures of this type of reproduction in an encyclopedia or a high school biology textbook.

Activities for children

1
The children may already be familiar with frog's egg masses. Collect some eggs early in the spring, and about 3 weeks later collect some more. You may wish to leave half of your eggs outdoors in a cool place so you can compare their development with those kept indoors. Does temperature have any effect in the development of the eggs? Keep a record of the daily changes in the egg development (a hand lens will help) on a chart. Spring peepers and toads will transform into small adults before school is out.

2
Make a chart to record the growth rate of newborn white mice or hamsters. List the weeks down the left-hand side of the chart. Headings across the top of the chart can read: weight, length, appearance of hair, color of hair, eyes opened, food, and movement.

3
Keep an ant colony in the classroom to observe the ant's life cycle and the care given to their eggs and larvae.

4
Tiny spiders hatching from their egg cases can be observed in the classroom. Find a female that is carrying an egg case (a round, cream colored or white paper-like ball attached to her abdomen or carried with her legs); place her in a glass jar, and cover it with cheesecloth. Supply her with food (small insects), and in a few days the tiny spiders will emerge from the egg case. Collect silky white spider egg cases under flat rocks or tree bark and keep them in the same type of container.

5
Children may bring caterpillars or cocoons to class. They can observe the changes which take place during the life cycle of these insects as they spin a cocoon, transform into a chrysalis, or emerge from the cocoon. In September, the caterpillar of the Monarch butterfly can be collected on milkweed plants. Put these in a coffee-can insect cage (see Kindergarten section of " Living Things "), and provide them with fresh milkweed leaves every day. In a few days, you may observe the caterpillar spin a button of silk, grasp this with its hind legs, and hang head down for about a day. Within 24 hours the caterpillar (larva) will split its skin and transform into green chrysalis (pupa) with golden spots. Keep close watch of the chrysalis for about 2 weeks. When the pupa turns brown or purple, the adult Monarch butterfly will emerge within 24 hours.

6
Aquatic snails can be found in ponds, streams or may be purchased from an aquarium shop. They require little care and need only a jar of water or a small aquarium in which to live. They will feed on algae or water plants, as well as on lettuce, that has been scraped in order to soften its outer skin.

They deposit their jellylike egg masses on the sides of the container or on objects in the water. A close examination with a hand lens will reveal the tiny coiled shells of the baby snails inside these eggs.

7
Have the children choose an animal that is of particular interest to them. Provide materials so that they may look up information about their animal. The children can then draw and color a large picture of the animal. Each child can show the picture to the class and give a thumbnail description of the animal.

8
If some dragonfly or damselfly nymphs are collected on a trip to a pond, put these in a shallow pan or aquarium. They will likely do better in water from which they were taken. The nymphs will feed on other animals in the water, or their diet can be supplemented with dead houseflies, mealworms, bits of meat, and earthworms. Keep some stones or coarse vegetation in the container under which these insects can hide. If a stick or board is placed in the water so the nymph can climb out and shed its pupal skin, the class may have the opportunity to watch the dragonfly emerge.

Fieldwork

1
Trips can be taken to places where newborn animals may be observed. Probably the best places to make direct observations would be zoos, game farms, dairy and poultry farms, pet stores, or a commercial establishment that raises animals for a specific purpose. The children may compare the baby animals to the parents and note the parental care given to some of the young animals. They may also find out how people help to care for newborn animals.

2
Visit a fish hatchery to answer the following questions: Where does the hatchery get the fish eggs? How do they care for the eggs before they hatch? What do they do with the young fish? How do they feed the fish? What do they eat? Where do they keep the fish? How long do they keep the fish at the hatchery? What do they do with the fish? What are some of the dangers faced by the fish?

3
Make a visit to a museum of natural history to see exhibits showing the life cycles of animals. Some museums display specimens of bird's eggs and other egg-laying animals. Notice the difference in the shape and color of the various eggs. Does the size of the egg correspond to the size of the bird? How many eggs do birds lay? Why are some bird's eggs colored? What advantage to a bird is there in the coloration of its eggs?

4
Arrange a visit to the biology laboratory of the high school. The lab will undoubtedly have some displays, teaching exhibits, or specimens which show the life cycles or the stages in the life cycles of animals. Many of these will be preserved (in plastic mounts or in museum jars) and children will be able to examine them closely.

5
Take field trips in the vicinity of the school building to look for evidences of insect's eggs. Make a list of the various places where these can be found. Collect a few insect specimens to take back to the classroom so they may be observed. Search out an ant colony to fill an ant colony container (formicarium). Collect some galls so that the children can watch for the emergence of the adult insect in the classroom.

6
Early in the spring visit a quiet stream, marsh, or pond to collect some frog or toad eggs for the classroom. Collect enough pond water to fill the containers which will be used in the school. Provide rocks or wood on which the amphibians may rest as they develop into adults. Pond scum or pond plants will supply food for the young when they develop from the egg.

7
Some birds may build their nests near or on school buildings. Children can be taken to a nest site to look at the eggs. What kind of bird build the nest? Note the color of the eggs. How many are there? Observe the behavior of the female bird on the nest. Look up information concerning how long it takes for the eggs to hatch, then visit the nest every day to see when they do hatch. What do the young birds look like? Check periodically to note the changes in the young birds. How does the female take care of the young? Does the male bird help? How long is it before they leave the nest? How long before they can fly?

ENRICHMENT

Questions to stimulate further thought

1. Do fish ever deposit their eggs on land?
2. Do all amphibians lay their eggs in water?
3. Can reptiles lay their eggs in water?
4. Are the young of all reptiles born from eggs?
5. Are the young of all mammals born alive?
6. How do mammals that live in the ocean care for their young?
7. Why are the children of humans cared for and protected by their parents for a longer time than any other animal?
8. How do insects continue to survive if they are the food source of so many other animals?
9. What are some examples of extinct mammals? What might have caused their extinction?
10. Why does a baby bear, dog, or lion need parental care, while a young fish or tadpole does not?
11. What happens to the weaker individuals among wild animals? Why do the strongest, most vigorous, and most clever have a better chance to grow up and become parents of the next generation?

Topics for additional exploration

1
Overproduction. Animals in nature overproduce; each pair of animals produces more than two offspring. Animals with birthrates too low to balance the death rate may become extinct.

2
The Platypus. The means by which the duck-billed platypus gives birth to its young is most unique among mammals.

3
Marsupials. Animals with pouches, such as kangaroos, care for young in an interesting manner. The opossum, a relative of the kangaroo, is the only animal native to the United States that has a pouch.

4
Regeneration. Some animals can grow new body parts to replace those lost (lizard, salamander, crayfish, planaria, etc.). However, these animals cannot produce new individuals this way.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make a chart to illustrate the four stages in the life of a typical insect. Make another chart to illustrate the life of a typical three-stage insect. Label the stages on each chart.

2
Make a classroom display which groups pictures of animals according to their method of reproduction and parental care. For example, show animals which lay eggs and abandon them, animals which lay eggs and care for them, and animals which produce live young.

3
Three-dimensional models showing the stages in the development of butterflies and moths can be made on a background of shoe-box or stocking-box tops. Use uncooked tapioca or rice kernels for the eggs. The caterpillar (larva) and cocoon, or chrysalis (pupa), whichever the case may be, can be made from papier-maché and painted. The adult insect is cut from construction paper and colored to match the specimen which is being studied. Glue the parts to their background and label each part.

4
Draw and label some enlarged diagrams of the microscopic animals which have been observed through the microprojector or microscope. A second look at these animals might help to refresh the memory. Draw a diagram which shows the splitting apart of these animals, a simple method of reproducing others of their kind.

5
Select an animal and keep a scrapbook which tells about the different stages of development in its life, including parental care. Include pictures wherever possible.

6
Plot the growth rate (body length or weight) of a newborn mouse or hamster on a graph.

Questions to guide a summary of experiences

1. Where do baby animals come from?
2. Do living things only produce similar living things?
3. What animals lay eggs?
4. Which animals feed and protect their young?
5. Why is it important that insects produce young in such great numbers?
6. Do the moth, rabbit, frog, and bird pass through the same stages during their development?
7. How do some microscopic animals produce others of their kind?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Living things are produced by similar living things.
2. Many animals lay eggs; others bear living young.
3. Some animals feed and protect their growing young.
4. Some animals produce many young at a time.
5. Some simple (microscopic) animals reproduce by breaking apart.

VOCABULARY

adult
amphibian
aquatic
bear
breathe
chrysalis
cocoon
feathers
life cycle
mammals
mature
microscopic
protect
reproduce
tadpole
young

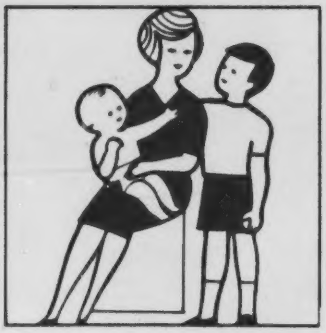
SCIENTISTS

Audubon, James
Burbank, Luther

Fourth Grade

b OUR GROWING BODIES

DIGESTION



PURPOSE OF THE UNIT: ***to acquaint the pupil with the basic elements of the process of digestion***

Apparatus and materials

1. Anatomical chart showing digestive system
2. Beakers, glass
3. Benedict's solution
4. Bunsen burner or hot plate
5. Butter
6. Cotton
7. Eyedropper
8. Fresh egg
9. Hydrochloric acid, 0.5% solution
10. Iodine
11. Lean meat
12. Lump sugar
13. Paraffin
14. Raw or pickled beef stomach
15. Starch suspension
16. Test tubes, clean
17. Test tube holder

INTRODUCTION OF THE UNIT

Motivating activities

1
Display a picture or anatomical model of the human trunk which shows the digestive tract.

2
Have each child locate his stomach by placing his hands on body directly over the stomach.

3
Give pupils an opportunity to draw and label, from the displayed picture or anatomical chart, a picture of the digestive tract. Later, the pupils may fill in the names of the parts they cannot identify.

4
The teacher may tell (or read) the story of William Beaumont and Alexis St. Martin and the original observations made by Beaumont on digestion. The story of the later work and observations by Pavlov on his dogs and the knowledge he added to the physiology of digestion will be appreciated by this age child.

Motivating questions

1. Why do we chew our food well?
2. Where does food go when we swallow?
3. What happens to food in our stomach?
4. Why can we eat so many different kinds of food?
5. How long does food stay in our stomachs?
6. Why does food need to be digested?
7. What do our teeth have to do with digestion?
8. Is everything that we eat digested?
9. What happens to the food which is not digested?
10. What happens to us when something we ate is not digested properly?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
With a lump of sugar and a beaker of water, the teacher may demonstrate how solids are dissolved in liquids. Solids cannot pass from the digestive tract into the blood stream. To be used, all food must be ultimately dissolved in the process of digestion.

2
The teacher may demonstrate samples of the three main classes of solid food (protein, fat, carbohydrate) by putting some egg white, butter, and sugar on a saucer. An important component of food (cellulose) may be illustrated by a wad of cotton.

3
Read a story to the children, or have them read a story which tells about digestion in ruminants.

4
A piece of lean meat placed in a beaker which contains dilute (0.5%) hydrochloric acid will disintegrate or become a soft mass illustrative of what (in part) happens to meat in the stomach. Note: The teacher must exercise caution when handling acids.

5
Have a child chew paraffin to stimulate the flow of saliva. Let this saliva be collected in a clean test tube. To a clean test tube containing a small amount of iodine solution, add a few drops of warm starch suspension. The resulting characteristic blue color is the test for the presence of starch. To another clean test tube containing about 5 cc. of warm starch suspension, add 2 cc. of saliva. Keep warm for about 30 minutes, then put 5 cc. of Benedict's solution in a clean test tube and add 1 cc. of the digested starch solution. Heat the test tube in boiling water for 5 minutes. The resulting red or yellow precipitate is the test for digested sugars.

Activities for children

1
From a local butcher or supermarket, some child may bring in either a piece of untreated stomach or a piece of tripe. This will give children an opportunity to see the construction of the stomach.

2
Have children fill in the names of those sections of the digestive tract they could not name when they made their drawings. At each segment, they may also fill in the particular digestive function carried on at that place.

3
Have pupils read stories which describe in simple terms the digestive process and what happens to food after it is digested.

4
The class may write a simple story about digestion such as " The Story of a Piece of Sugar " or " When I Eat a Piece of Bread." This allows some imagination, plus factual information.

5
The class may do some research and report on it either orally or in writing. The research could deal with what food is digested most rapidly, what food is digested very slowly, and what foods are not digested to any significant degree.

Fieldwork

1
Have the class visit the homemaking room to ask the teacher why we cook much of our food rather than eat it raw, as many animals do.

2
At the next physical education class, have the pupils ask their physical education teacher why it is better not to run, jump, and play hard immediately after a big meal.

ENRICHMENT

Questions to stimulate further thought

1. Why is our intestinal tract so long?
2. Why does the process of digestion have to be so complicated?
3. Why does thorough chewing make digestion easier?
4. Should we avoid drinking water with our meals?
5. Does the way we feel affect our digestion?
6. Can we digest our food by merely thinking about it?
7. Why do our mouths water when we see or smell food?
8. Tell why our teeth are an important part of digestion.

Topics for additional exploration

1
The absorption of food. Through research in simple physiology books or discussion in class, the story of food absorption from the digestive tract into the blood stream can be learned.

2
Peristaltic action. How food moves along the intestinal tract can be demonstrated to the class by using a marble or steel ball in a thin rubber tube. Pressure behind the ball will push the ball farther along the tube.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
The pupils may trace the course of some food through the digestive tract showing where each of the basic food elements contained in the food chosen is digested, and what body secretion is responsible for the digestion.

2
For a more realistic idea of the length and complexity of the digestive system, the pupils may stretch a length of strong cord in the room which approximates the length of the digestive tract. This may be divided into the component parts of the system showing the relative size of each part. Labels may be attached to show the process carried on in each part, and the secretion responsible.

Questions to guide a summary of experiences

1. Why is it necessary to chew food thoroughly?
2. How long does food remain in the stomach?
3. Is all digestion carried on in the stomach?
4. Why is digestion necessary?
5. Which foods are digested quickly? Which slowly?
6. Why should we be quiet and happy before, during, and after meals?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Digestion is the process of breaking food down into smaller chemical parts so it can be used by the body.
2. Only complete digestion of food can give us the full benefits of what we eat.
3. The undigestible portions of food (cellulose) is necessary for the normal functioning of intestines.
4. Different parts of the digestive tract have quite different functions in the total process.
5. We are able to eat what we wish, rather than choose foods of the same type, because the entire digestive system functions whenever we eat.
6. Activity and emotions may have an adverse effect on digestion.

VOCABULARY

absorption
cellulose
digestion
dissolved
esophagus
hydrochloric
intestine
iodine
paraffin
peristaltic
ruminant
saliva
stomach
thorough

SCIENTISTS

Beaumont, William
Pavlov, Ivan
St. Martin, Alexis

Fourth Grade

C AIR, WATER, AND WEATHER

WATER

PURPOSE OF THE UNIT: *to determine the source of our water*

Apparatus and materials

1. Bottle, large, wide-mouthed
2. Bottles, milk
3. Bottles, soda
4. Can, metal, fruit or vegetable
5. Cup, measuring, or graduated cylinder
6. Florence flask
7. Flowerpot
8. Geranium or coleus plant
9. Hand lens
10. Lift pump, demonstration
11. Pan, pie
12. Rain gauge
13. Sand
14. Scales, or balance
15. Sponge
16. Tube, glass, large bore
17. Tumbler, water

INTRODUCTION OF THE UNIT

Motivating activities

1
Obtain a rain gauge from the high school earth science teacher or from an amateur weather observer. Set up a " What Is It? " display.

2
Display pictures of lakes, streams, rivers, and the ocean. Place a note on the bulletin board: " Where does this water come from?"

3
Fill a common clay flowerpot with well moistened soil; weigh it as carefully as possible. Record this weight. Place the pot of soil on a sunny window sill or in a warm place for the day, and weigh it again at the end of the school day. Can the children account for the loss of weight?

4
Make a sign, " What is precipitation?", and place it on the bulletin board. Let children supply pictures of examples.

Motivating questions

1. Where does the rain come from?
2. Where do the clouds come from?
3. Which places on the earth receive very little rain?
4. Are there any deserts in the United States?
5. What is precipitation?
6. What is evaporation?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

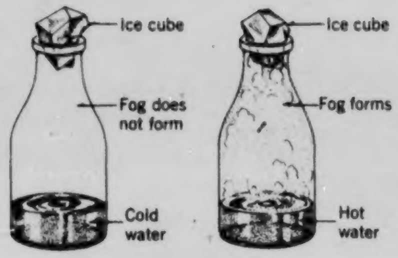
1
Rub a wet sponge over the surface of the chalkboard and watch the film of water evaporate. Where does this water go? Repeat with rubbing alcohol. Can the children smell it after it evaporates? What does this imply?

2
Dip a cloth in water, wring it out, and hang it over a clothes hanger. Hook the clothes hanger on a scale or on one end of a balance. As the water evaporates, its weight will change noticeably. Have the children discuss other examples of water entering the air by evaporation.

3
Cover a geranium or coleus plant with a large wide-mouthed bottle, or wrap the entire plant in a clear plastic bag. Place the covered plant in a sunny spot; notice the drops of water that form inside the container. Green plants give off great quantities of moisture into the atmosphere.

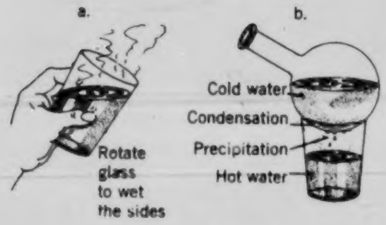
4
Using a graduated cylinder or a measuring cup, pour equal amounts of water into a pie pan, a tumbler, and a soda bottle. Have children speculate on the length of time it will require for this much water to evaporate. Set all three containers aside where they will not be disturbed. Observe them each morning and afternoon. When the pie pan is dry, measure the amount of water left in the tumbler and the bottle. Did any water evaporate from the tumbler and the bottle? Why were the evaporation rates different?

5
Place some ice and water in a metal can, such as a fruit can, which has had its top and label removed. The cold metal will cool the air next to the can and the water vapor in the air will condense out on the side of the can. Wipe the outside of the can dry with a handkerchief and watch the moisture reappear. Relate this occurrence to the condensation on the outside of cool water glasses on a hot day. To show that the moisture is not seeping through the metal, fill the can with water at room temperature and no condensation will occur. Another variation would be to add a few drops of ink to the water and ice mixture. Wipe the moisture from the can and look for the color on the cloth.



6
Fill a milk bottle with hot water. Then pour out most of the water, leaving about an inch in the bottom. Place an ice cube on the mouth of the bottle, as shown in the diagram. Set up a control, using cold water instead of hot. Have pupils speculate as to why fog forms in one bottle but not in the other.

Note: In our atmosphere, the rising air is cooled as a result of expansion, rather than as a result of coming into contact with a cold body.

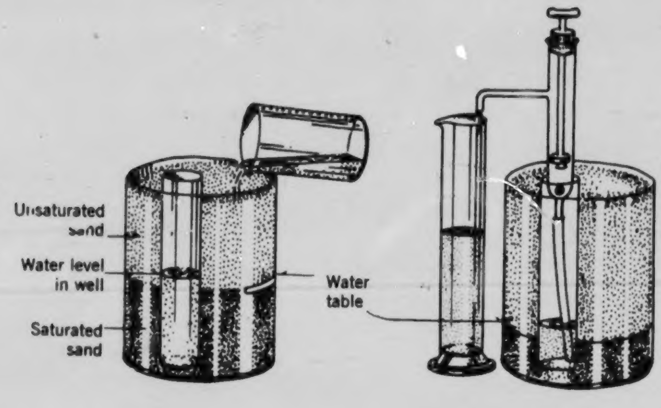


7
After the class has an understanding of the processes of evaporation and condensation, and the process of the water cycle, pour some hot water into a drinking glass until it is about two-thirds full. Rotate the glass so as to wet the sides all the way to the top. Now put some cold water into a Florence flask and set the flask on the glass at an angle, as shown in the diagram.

Water will evaporate from the surface in the glass and condense on the cold flask. Drops of the condensed water will continue to fall back into the glass for many minutes. This demonstration makes an extremely simple approach for developing the concept of the water cycle.

Note: Actually, in our atmosphere, the rising air cools and expands as the pressure on it is reduced. As the air rises, the relative humidity also keeps rising. When the relative humidity is 100 percent, the air is holding all the moisture it can. Continued rising will usually mean that some form of condensation will occur.

8
A simple model that can be set up within a short time presents an excellent approach to the development of the concept of the water table. Hold a large bore glass tube against the inside of a battery jar to represent a well. Fill the jar with sand and pour water on the sand until the water level rises about halfway in the jar. Note that the water level is the same outside the well as it is inside the well. Paste a narrow strip of wet paper on the jar to mark the water level and develop the term water table. Use a demonstration lift pump to remove some of the water from the well and call attention to the lowering of the water table.



9

It will be obvious to pupils that the source of soil water is rainfall. The height of the water table depends to a large extent upon how well water can penetrate the soil. A large amount of runoff occurs where soils are relatively impervious to water. Most of this runoff water is carried away by streams and does not help raise the water table. The relative water permeability of soils of different kinds can be demonstrated very easily with a metal can with both the top and bottom removed, a watch, and a pail of water. The metal can should be one that has been opened at both ends with a rotary can opener, so that the rims are smooth. Press the can into the ground to a distance of about 1 inch and fill it completely with water. Use a watch to demonstrate the time required for all the water to go into the soil. Repeat the procedure in different places, such as the playground, the lawn, and a cultivated area. The data obtained may be summarized in tabular form.

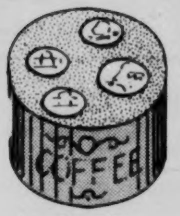
Activities for children

1

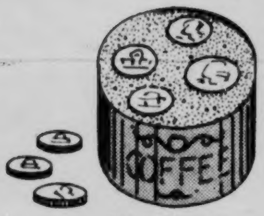
Have the children write a short story describing the journey of a raindrop from the time it leaves a rain cloud and following it as it moves from one place to another. Read some of the more thoughtful stories to the class the following day and invite further discussion.

2

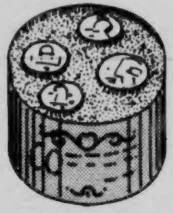
Excellent charts or illustrations of cloud forms can be made with white chalk on blue construction paper.



Dry soil



Effect of light rain



Effect of heavy rain

3

Make small drainage holes in the bottoms of several pans or cans and fill with loose soil. Press down the soil so that it is even with the edges of the pan. (Flowerpots can also be used.) Place coins, bottle caps, or flat stones on the surface of the soil, as shown in the diagram.

Set the cans in a large pan. Sprinkle these with water from a watering can held about 2 feet above them. Continue the simulated rain until a change can be noticed in the surface of the soil. Repeat the above, but set the pans of soil outdoors during a rain. Notice how the unprotected soil is splashed away, leaving columns under the bottle tops or coins undisturbed.

Fieldwork

1

Make daily observations of clouds. If a camera with a filter is available, cloud photographs can be taken and developed into an excellent exhibit.

2

Take children outside on several cold snowy days. Examine snowflakes which fall on dark clothing with hand lenses. Note their shapes. How many points are there on the snow crystals?

3

Arrange a trip to a reservoir.

4

Ask pupils to tell of places in the vicinity of the school where there is evidence that the water table is near the surface. Swampy or marshy locations, even though they are small in area, can usually be found at a distance that is not too far for a short field trip.

In conducting a field trip of this kind, one of the significant observations that can be made is the difference in the vegetation as compared to adjacent drier areas. Some of the plants such as cattails, marsh marigold, pussy willows, and various swamp grasses, which grow only in wet locations, can be identified by their common names. If the field trip is taken in early spring, it will often be possible to find the water table by digging a small hole with a shovel. Attention should be called to the fact that the water table is usually nearer the surface in spring than at other times of the year.

ENRICHMENT

Questions to stimulate further thought

1. Why were the annual floods of the river Nile beneficial?
2. What is the rainiest place in the world? How much rain falls there?
3. Where is groundwater exposed at the surface of the earth?
4. Since snow is not frozen rain, where do snowflakes come from?
5. Are clouds always made of water droplets?
6. What is the meaning of the word "desert"?

Topics for additional exploration

1
Precipitation records. The almanac gives annual rainfall in the major United States cities, as well as world records of such data as highest recorded temperature, lowest recorded temperature, record rainfall, and record snowfall.

2
Water vapor. Not only does water vapor enter the air from green leaves and direct evaporation, but animals exhale water vapor. This is clearly seen on a cold day or can be demonstrated by breathing on a cool piece of glass. How much water does a person exhale during a day?

3
Relative humidity. The amount of water vapor in the air is often measured in terms of relative humidity. When the air is holding as much water vapor as it possibly can, the relative humidity is said to be 100 percent. When the air is holding half as much water vapor as it can hold, the relative humidity is 50 percent.

4
Hailstones. Hailstones are not simply frozen raindrops. If cut open, they show a number of concentric spheres which have resulted from their formative process.

5
The atmosphere as an insulator. What radiations from the sun would harm us if the earth had no atmosphere?

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make a large mural depicting the entire process of the water cycle.

2
Make a cloud display for the bulletin board. Use either photographs or sketches; place the clouds at the proper relative heights to each other. Label cloud names and their individual characteristics.

3
Make a rainfall map of New York State. This may be a flat projection or a relief map made of papier-maché or salt flour to compare surface features to amount of rainfall in different regions of the State.

4
Make rain gauges for use in different locations on the school grounds. Does rainfall vary?

Questions to guide a summary of experiences

1. What is precipitation?
2. Why are clouds usually high in the sky?
3. What is evaporation?
4. Why haven't all the oceans evaporated in the past years?
5. What is the water cycle?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Water evaporates into invisible vapor.
2. When water vapor cools, it condenses into liquid.
3. Condensed water vapor falling to the ground is called precipitation.
4. Rain, snow, sleet, and hail are all forms of precipitation.
5. Some precipitation soaks into the ground, while some runs off into streams, lakes, and oceans.
6. Excessive precipitation causes great damage by erosion and flood.
7. The process of continuous evaporation and condensation is called the water cycle.

VOCABULARY

altitude
atmosphere
condense
desert
erosion
evaporate
extreme
flood
groundwater
precipitate
surface water
vapor
water cycle

Fourth Grade

d THE EARTH AND ITS COMPOSITION

ROCKS

PURPOSE OF THE UNIT: ***to learn about classification of rocks and what rocks tell us about our earth***

Apparatus and materials

1. Bottles, quart
2. Double boiler
3. Feldspar
4. Granite
5. Hand lens
6. Hot plate
7. Paraffin
8. Pie tins
9. Plaster of paris
10. Portland cement
11. Pumice
12. Quartz
13. Rocks, collection of common New York State varieties
14. Rocks, containing fossils
15. Rocks, igneous, sedimentary, and metamorphic types
16. Sand
17. Shellac
18. Vaseline, or liquid soap

INTRODUCTION OF THE UNIT

Motivating activities

1
Display a piece of granite or similar rock which contains several minerals, and provide individual specimens of each mineral which makes up this piece of granite. Examples: quartz, feldspar, and mica. Provide a hand lens for close inspection.

2
Display some rocks containing fossils.

3
Arrange a display of books which relate to the subject on a library table or in the science corner.

4
A rock, fossil, and/or crystal may be used for a "What Is It?" display. Display a resource book with the specimen. To stimulate some interest, make a small ballot box. Ask children to write their names and what they think the specimen is on a small slip of paper, and put it in the ballot box. After a few days, open the box to see how many students were right.

5
Make a bulletin board display of pictures or diagrams of a salt mine, iron mine, or a coal mine.

6
Many appropriate films and filmstrips are available which may be used to introduce students to this topic.

7
Display some rocks which differ from each other in appearance; include examples of igneous, sedimentary, and metamorphic rocks. Several pupils will probably have rock collections which they will be willing to share with the class.

Motivating questions

1. What is rock?
2. Are all rocks the same?
3. What are fossils?
4. Where are fossils found?
5. Have you noticed differences in the color, hardness, and stratification of rocks?
6. Do you recognize this rock? (Granite)
7. How do we make use of it? (Monuments, buildings)

Note: Two words not always clearly defined are "rock" and "stone". Rock is the material, composed of minerals, that makes up a large portion of the earth's crust. There are many kinds of rock, such as granite, slate, and limestone. When man makes use of rock or when we make references to a specific piece of rock, the pieces are referred to as stone. We speak of stone houses, stone walls, stone monuments, tombstones, and precious stones, but we find rocks out in the field. When introducing the terms sedimentary, metamorphic, and igneous and when describing each of these classes of rock, do not tell your children that igneous rocks are "fire-formed" rocks. Fire cannot form rocks. No rock is formed from flame of any sort. The interior of the earth is hot, but not from burning fire.

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
Rocks and minerals, like most other substances, will melt when sufficiently heated. To demonstrate this change from solid to liquid to solid again, a block of paraffin can be melted in a pan over an electric hot plate. A double boiler, although slower, will reduce the chance of accidents due to splattering. Pour melted paraffin down a cardboard slope; note its shape as it solidifies. When lava flows, it hardens in the same manner. This demonstration should be performed by the teacher only.

2
Pour a cup of portland cement into a quart bottle filled with one-quarter sand, add water, and shake contents until thoroughly mixed. Let it stand for 24 hours. Pour off the excess water and observe " sedimentary " rock.

3
If a piece of pumice (an igneous rock) is available, show that it will float on water. Why will it float? How did such an odd formation take place?

4
With the aid of the children, a teacher can collect interesting rocks and associated minerals to keep as a permanent growing classroom exhibit. Samples of quartz and granite are striking, fairly easy to find, or cheap to buy from a science supply house.

5
Many rocks and minerals have a natural sheen or shininess, called " luster " by geologists, which is dulled as they are rubbed and worn by sand and other rocks. Quartz, which has a very high glassy luster, is often found as oval, dull grey pebbles. To see the true luster of such a specimen, the teacher can wrap the pebble in heavy cloth such as denim, place it on a larger rock, and hit it sharply with a hammer. These freshly exposed surfaces will also show the true color of the specimen.

6
Invite the high school earth science teacher to speak to the class about local rocks and their formation.

7
Amateur geologists and mineral collectors are found in many communities. They may serve as valuable resource people in discussing local geology and locations of important rock features.

8
Label a display of rocks which have been formed under igneous, sedimentary, and metamorphic conditions. Arrange some to show the before and after appearance of rocks that have undergone a change. Example: limestone which becomes marble.

9
Make a display of common rocks which are found in New York State, such as granite, limestone, sandstone, dolomite, conglomerate, and others. Specimens may be collected locally or obtained from the State Museum on loan. Supply houses sell such specimens at a nominal fee.

10
The children may help the teacher make a collection of interesting fossils to keep as a permanent, growing, classroom exhibit. Those that cannot be collected near the locality of the school may be obtained free or very cheaply from other sources, such as museums and supply houses.

Activities for children

1
Examine granite and note the different colors of minerals in it. (Use a hand lens for a close-up view.) Quartz is the glassy mineral. Feldspar is white, an off white, green or pink, and has a pearly luster. Much granite has flecks of mica in it. The mica is silvery, and soft enough to be scratched with a fingernail. How do you think a rock composed of such a mixture of minerals could have been formed?

2
Note the colors of minerals which are found in rocks. Many igneous and metamorphic rocks exhibit a variety of colors.

3
After the pupils have seen examples of different kinds of rock, let them separate a pile of rocks into igneous, sedimentary, and metamorphic groups.

4
Write a short story describing the " biography " of a piece of marble or slate.

5
Make fossil-type imprints of leaves. Apply a thin coating of vaseline or liquid soap to a flat leaf (maple, elm, oak); lay this in a pie tin or any shallow metal or plastic container. Pour about ¾ inch of plaster of paris into the container and allow it to solidify. Remove the plaster from the pan and carefully pull the leaf out of the casting. Labels can be scratched into the cast. Water colors can be used to paint the cast to make an attractive and more permanent display. When the paint is dry, apply a coat of shellac. Relate this to the formation of fossils in nature.

6
Find out what the word geology means. Look up information about the work of a geologist.

7
Partially fill a small paper plate with damp sand. Smooth the surface of the sand, then make impressions using various objects such as shells, pencils, erasers, and marbles. Pour a mixture of plaster of paris over these impressions and let it harden to a casting. Remove the cast and brush away the excess sand. This activity will give the children some idea of one way in which fossils are preserved.

Fieldwork

1
Take a trip to a nearby museum to see rock, mineral, and fossil collections.

2
Visit sites which are under construction, such as road cuts, bridges, dams, or buildings. Quite often fresh rock exposures may be observed in these localities and, in addition, they provide a source for rock and mineral specimens. If any collecting is undertaken, however, it should be done only after permission has been granted and under proper supervision.

3
Visit a place where building stone is quarried. Find out what kind of rock it is, what it is used for and why, and the methods of quarrying. The trip should be timed when workers are not blasting at the quarry.

4
Take a trip to a gravel bank to see how many different kinds of rock may be found there. See how many you can recognize. Collect a few specimens for exhibit. Bring some " new " discoveries back to school to see if they can be identified.

5
There are many fossil-collecting areas in New York State. If the school is in such a locality, a fossil-collecting trip would be a most profitable experience. Care should be taken to preserve fossils that cannot be collected. If you think you have a rare find, it should be reported to a responsible agency. The extent to which directed trips around the school premises will be interesting and profitable depends on the location of the school. City schools with paved play areas will have to plan a trip to a nearby park for field work.

ENRICHMENT

Questions to stimulate further thought

1. Why don't all fish that die in lakes or oceans become fossils?
2. Why are scientists so sure that there were no men on earth during the days of the dinosaurs?
3. Why are there never any fossils found in granite?
4. Since dinosaurs lived millions of years before man, how do we know what they looked like?
5. How is it that fossil fish and shells are found in rock high up in mountains?
6. How can we tell which dinosaurs ate meat and which ate plants?
7. How do fossils tell us that the climate of Alaska was once tropical?
8. Which type of rock was probably first formed on earth, igneous, sedimentary, or metamorphic?
9. Fossils are presently being formed within the layers of new rock formations which are continually being built up under water year after year. Where would you expect to find the oldest fossil remains, in the lower layers or the top layers? Why?
10. Why are some fossil remains abundant and others, such as those of birds, very scarce?
11. What type fossils are most abundant, those of water-dwelling or land-dwelling animals? Why?
12. Some of the chemicals (molecules) that compose the body of a fourth-grader may have also been part of a dinosaur that lived over 100 million years ago. How can this happen?

Topics for additional exploration

1
Value of rocks and minerals. Man has many uses for rocks and minerals, such as for abrasives, building material, fuel, and metal ore.

2
Fossils. Fossil remains may be found as any of the following forms: (1) hardened prints or impressions, (2) parts or all of the preserved bodies, (3) casts of plants or animals, and (4) petrified remains.

3
Geologic time. Geologists have divided the earth's geologic history into periods and eras from information gained from fossil evidences and rock formations. Man's recorded history on earth may be compared to the age of the earth with a geologic time line or chart.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make a collection of local rocks.

2
Make dioramas depicting various ages of prehistoric life such as the Age of Reptiles and the Age of Mammals. Animals and backgrounds may be constructed from papier-maché. These may be made in shoe boxes, cigar boxes, or larger containers. A pleasing effect may be obtained by building the exhibit against a curved background.

3
Make plaster of paris models of fossils. Obtain a rock containing a fossil imprint. Build a wall of plastic clay ½ inch high around the imprint. Coat the imprint and the surrounding rock material with liquid soap or vaseline, so that the plaster cast may be easily removed from the rock. Pour plaster of paris into your homemade mold, so that it is almost level with the enclosure. When the plaster of paris has hardened, remove it from the rock containing the fossil imprint. The result will be a mold of the fossil. This may be labeled and coated with shellac or a plastic spray to preserve it. Several of these forms could be used as part of a diorama.

4
Make a chart of common New York State rocks. Include information, such as the name of the rock, where it was formed, where it was found, and uses for it. If specimens of the rocks are available, glue or tape them to the chart. Children may also draw and color pictures of the rocks for the chart.

5
Make a simple geologic chart showing the dominant life of different periods of time. If fossil specimens are available, they may be included as part of the exhibit.

6
Make a mural depicting the formation of a fossil fish, or the development of a modern coal mine from ancient fern forests.

Questions to guide a summary of experiences

1. What are rocks?
2. From what are rocks made?
3. How are rocks classified?
4. How was sandstone formed?
5. How was marble formed?
6. How was granite formed?
7. What are rock-forming materials?
8. What are fossils?
9. How do fossils tell us about life that existed in our world long ago?
10. What is a geologist? What does he do?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Rocks are grouped as igneous, sedimentary, and metamorphic.
2. Igneous rocks form when magma or lava cools.
3. Sedimentary rocks are formed when sand or other sediment is compressed and cemented into rock.

4. Metamorphic rocks are formed from other rocks which have been heated or squeezed into new forms.
5. Rocks are composed of minerals.
6. Three common rock-forming minerals are quartz, feldspar, and mica.
7. Fossils are evidence of life in the past and may be found in sedimentary rock.
8. A geologist is a scientist who studies the history of the earth and the rocks and minerals which make up the earth's surface.

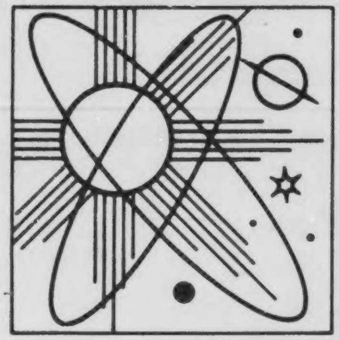
VOCABULARY

extinct
feldspar
foliated
fossil
geologist
granite
igneous
lava
magma
metamorphic
mica
mineral
rock
rock formation
sedimentary
stratification

Fourth Grade

e THE SOLAR SYSTEM AND BEYOND

MOVEMENTS WITHIN THE SOLAR SYSTEM



PURPOSE OF THE UNIT: ***to learn about movements within the solar system***

Apparatus and materials

1. Aluminum foil
2. Bead, small
3. Boxes, shoe
4. Christmas ornaments or tennis balls
5. Film slide
6. Flashlight or filmstrip projector
7. Globes, four
8. Household cement
9. Nails, finishing
10. Paint, black
11. Pins
12. Plastic clay
13. Styrofoam
14. Thread
15. Toothpicks
16. Wire screen

INTRODUCTION OF THE UNIT

Motivating activities

1
Arrange a bulletin board display of pictures showing the different seasons. Near each picture place signs asking why we have spring, summer, fall, and winter.

2
Illustrate temperature differences for the same time of year in various regions of the United States. Examples may include winter scenes in New York State and Florida, the Texas panhandle and southern Texas, the Arizona plateau region and the desert region, and the Pacific northwest coastal region and the New England coast.

3
Exhibit pictures illustrating differences between high and low tide. Place a newspaper report of tide tables near the pictures. Pictures of the Bay of Fundy at low and high tide are spectacular.

4
Reconfirm concepts about length of shadows by observing and measuring the changing shadow of the flagpole.

Motivating questions

1. Does the earth have temperature zones? What are they?
2. Why do some people go south in the wintertime?
3. What are tides?
4. What causes tides?
5. Why do planets shine?
6. Does the moon rise at the same time each day?
7. What is the sun?
8. What is the moon?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
Direct the beam from a flashlight or filmstrip projector on a piece of cardboard in a vertical position. What is the shape of the spot of light? Now tip the cardboard slightly. What happens as the cardboard is tilted further?

2
This simple demonstration showing why the heating effect of the sun is greatest at the equator will require some preparation, but will be well worth the effect.

Obtain an old 2 inch by 2 inch colored film slide. Pry apart the cardboard carefully; and remove the film from the frame. Using household cement, insert a piece of metal window screening and glue the cardboard frame back together so the slide looks like figure 1.

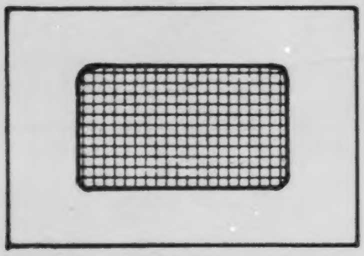
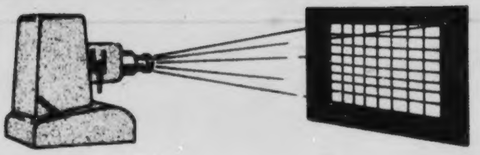
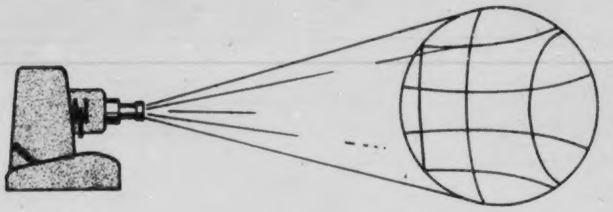


Figure 1

The audiovisual person in your school can probably make this slide for you very easily with the materials he has on hand. Place the mounted screen in a film projector, and focus the image of the screening on a chalkboard. Locate the projector so the projected squares are about 1 inch on a side. Using chalk, trace some squares on the board; note similar size and shape. (see figure 2). Next, focus the projector on a white volleyball (which will represent the earth). The children will immediately see how the squares have become distorted when they are projected on the rounded surface (see figure 3). The squares in the center of the lighted surface are still nearly their true shape, but out toward the edges of the sphere, where the poles would be, the little squares of light have spread out over a very large area. Have the children consider how the amount of heat and light received by any point on the globe is affected by the amount that the incoming energy is spread out.





3

Obtain four globes. Arrange them around the four quarters of a circle. Make sure the earth's axes are all tilted in the same direction (towards an imaginary North Star). Darken the room and place a light in the center of the four globes. You will note that one globe has its axis inclined toward the sun, while on the opposite side, the axis is inclined away from the sun. The globe with its axis inclined toward the sun represents the place of the earth in its orbit with relation to the sun at about June 21. You will notice that the northern hemisphere receives more of the sun's rays than the southern hemisphere. At this time, the sun would appear to be almost directly over the head of a person standing 23½° north of the equator. The line on the globe which is 23½° north of the equator is called the Tropic of Cancer. This is as far north as the sun will ever appear to be directly overhead. Rotate the globe in this position to note the difference in length of day and night. Note that when the earth is in this position, more than half of the northern hemisphere is lighted, therefore the days are longer than the nights in the summer.

The globe on the opposite side of the light will have the northern hemisphere tilted away from the sun and the southern hemisphere receiving the majority of the solar radiation. This occurs about December 21, and is the beginning of summer for the southern hemisphere and winter for the northern hemisphere. At this time, we see the sun low in the southern sky. Note differences between the relative length of night and day.

The other two globes represent the location of the earth in spring and fall on March 21 and September 23. At both positions, the light appears to fall equally on both hemispheres. The sun would appear directly overhead at the equator and day and night would be of equal length.

As the earth travels in its orbit around the sun, the earth's axis remains inclined in the same direction, pointing toward the North Star.

Note: The sun never shines straight down on any spot in the United States. The only zone where the sun shines from directly overhead is between the Tropic of Cancer and the Tropic of Capricorn. No point within the continental United States is south of the Tropic of Cancer.

4
Cut a hole about ½ inch in diameter in a dark piece of construction paper, which has been cut to fit in a window pane. This should be arranged so the sun's rays will be directed to a place on a table or floor. On a piece of paper, trace around the spot directed from the light which passes through the hole, and mark the date and time. Repeat this several times on succeeding days ***at the same time.*** After several days you will note a change in the direction of the spots, either nearer or further from the window. This change in the position of the spots calls attention to how the sun's rays strike the earth at different angles on different days.

5
When explaining the planetary motions to the children, try to minimize the terms " centrifugal " and " centripetal " force. It is more accurate and straightforward to get children to think in terms of inertia and gravity.

Inertia is a term which means, in part, that moving objects try to travel straight ahead. If a cannon were fired from a high mountain, and if there were no gravity, the projectile would travel as shown in figure 1.

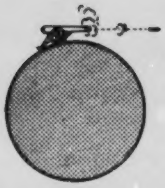


Figure 1

But, in reality, as the projectile moves away from the earth, gravity pulls it back toward the center of the earth. If the gravity pulls the bullet toward the earth's center just as fast as the inertia carries the bullet away from the center of the earth, the result will be an orbiting projectile. (See figure 2.)

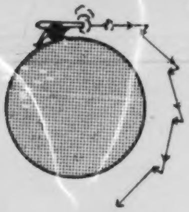


Figure 2

As the moon moves around the earth, its inertia tends to make it move off as shown in figure 3, but the gravitational attraction of the earth keeps pulling it back into its orbit with the result that it continues to revolve around the earth indefinitely.

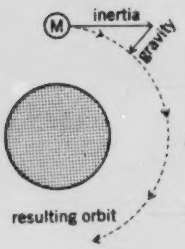


Figure 3

6
Suspend models of planets made from styrofoam, Christmas ornaments, or tennis balls. Darken the room. Are these models easily seen? Shine light on them. Can you see them better now? Do planets produce their own light?

7
Obtain a horoscope from a newspaper or almanac. Discuss astrology and the signs of the zodiac as used to make predictions. About 10,000 people are born each day in our country. The horoscope says the same thing for all of them. Could it be that this many people will all have the same fortune? Astrology is a pseudoscience and is not based on scientific information or observations. What kind of people generally believe in superstitions?

8
We may get a true picture of the moon's influence on the earth if a better understanding of its relative size and distance from the earth is examined. Let the earth be represented by a globe 1 foot in diameter. We know that the earth is nearly 8,000 miles in diameter and the moon about 2,000 miles in diameter, or about one fourth the diameter of the earth. If the 1-foot globe represents the earth, then the moon would be about the size of a 3-inch tennis ball. Compare the scaled distance of the moon from the earth with what the children imagine it to be by holding the tennis ball 1 foot, 2 feet, 5 feet, and 10 feet from the earth. What are the children's reactions? The average distance between the earth and the moon is really 240,000 miles, so on this scale the tennis ball should be held 30 feet from the globe to give an accurate picture. Measure off this distance and demonstrate. It may be pointed out that, according to this scale, the sun would be approximately 2 miles away.

Activities for children

1
Diagram the position of the earth in its orbit for the different seasons. A model of the earth may be cut from construction paper and placed at the proper intervals along a line drawn on a larger area of paper representing the earth's orbit. Draw the equator, the Tropics, and the polar circles on the representations of the earth. Make sure the earth's axis is inclined correctly. Shade each representation to illustrate the area of the earth's surface receiving the direct rays of the sun. Label each with the season and the approximate date. The restriction of space will not allow an accurate representation of the relative sizes of the sun and earth or the distances between them.

2
On large mural paper, draw a diagram of the earth and locate the various temperature zones. Keep a chart showing the phases of the moon for each day of a month. Estimate the time when the moon will rise from day to day, based on the time for the previous day. Have the children try to predict moonrise time for a future date.

3
Show movies and filmstrips about the earth-moon relationship to explain the ocean tides.

4
Collect some superstitious sayings about the moon and planets. Discuss them. Have the children design an experiment to discover for themselves whether or not the phases of the moon affect the growth of seeds.

Fieldwork

1
Plan evening meetings to observe planets and the moon.

2
Take a trip to a planetarium.

ENRICHMENT

Questions to stimulate further thought

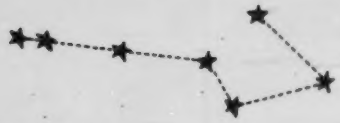
1. It is a fact that the earth is closest to the sun in January and most distant from the sun in July. Why, then, is it cold in January and warm in July?
2. What would happen if the earth's axis were tilted more than 23½° from the plane of its orbit?
3. What would happen to our seasons if the earth's axis were vertical and not inclined at all?
4. What planet is probably most like our earth?
5. If you lived on another planet, would the stars be visible to you?
6. How long would it take to travel to the nearest star beyond our solar system?

Topics for additional exploration

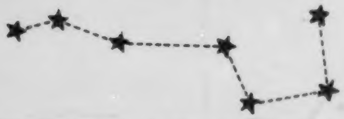
1
The moon's orbit. The moon's orbit is inclined approximately 5° to that of the earth. If the moon revolved around the earth in the same plane as the earth's orbit, there would be an eclipse every month. Due to the inclination of the moon's orbit, the earth, moon, and sun fall in a single line only occasionally.

2
Apparent fixed position of stars. All the stars visible in the sky are in motion, yet they appear to hold their position year after year. Our grandparents could see the big dipper and so can we. Because of this, we tend to think of the stars as fixed in one position, but each of the stars in the constellation is traveling in its own individual path. The reason we are unable to visually notice these changes is that the distances involved are so tremendous.

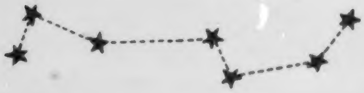
The Big Dipper 100,000 years ago



The Big Dipper today



The Big Dipper 100,000 years from now



← Each star in the big dipper is many billions of miles distant from the next star in the constellation. During a few years their motions are relatively insignificant because of this great distance.

3
Inclination of planets' orbits. The inclination of the earth's axis is not peculiar to our planet alone. The axes of other planets in the solar system are tipped to varying degrees depending on the planet. Uranus is tipped so far that its axis is nearly parallel with its plane of revolution.

4
Sun's altitude and earth's latitude. Locate the latitude (to the nearest whole degree) of your city or town on a map of New York State. The latitude of 43° north passes through the middle of the State. If you lived in Utica or Syracuse, your latitude would be about 43° north on the map of the United States or the world; locate other prominent cities at the same latitude. When your latitude has been determined, find out how far up in the sky the sun will appear at noon on June 21 and December 21.

5
Astrology. A pseudoscience which claims that human destiny is controlled by the positions of the stars and planets.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make a large mural depicting the planets' orbits around the sun. Include a scale showing relative sizes.

2
Make a model solar system to hang from the ceiling of the room. Have the children decide on a scale to represent the distance of the models from the sun. Large lightweight globes can be made by using papier-maché.

3
Make shoebox solar systems, with planets suspended with thread from the top of the shoebox. The planets can be made from aluminum foil and plastic clay. Pins stuck into the models will represent satellites of the planets. Paint the inside of the shoebox black to serve as a background.

4
Set up a model of the solar system on the playground. The following is a suggested scale for interpreting the distances of the planets from the sun.

	MERCURY	VENUS	EARTH	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Distance from the sun in millions of miles	36	67	93	141	483	886	1,783	2,794	3,670
Diameter in miles	3,100	7,700	7,900	4,200	88,700	74,200	32,400	31,000	8,000
Scaled distance from the sun in inches (if the sun's diameter is considered to be 850,000 miles and the scale used here is 1 inch to 850,000 miles)	42	78	108	163	560	1,025	2,063	3,233	4,247

Fourth-graders can convert the distance in inches to feet as an exercise in mathematics. This will facilitate measuring when setting the project up outdoors.

Children may be located at these scaled distances from the "sun" holding a very small bead to represent a planet. This should help develop an appreciation of the enormity of space.

5
Make charts illustrating differences between high and low tide.

6
Make a model showing the earth's position on its orbit during the different seasons. Miniature earths may be made from styrofoam or other balls pierced with toothpicks to represent the earth's inclined axis. Mount them on finishing nails driven through a board. Label each position and indicate the direction of revolution.

Questions to guide a summary of experiences

1. What is the cause of the world's temperature zones?
2. What are the names of the earth's temperature zones and how many are there?
3. What causes the change in the seasons?
4. Do planets produce light?
5. What keeps the moon in its orbit?
6. What causes tides?
7. How do planets differ in size and distance from the sun?
8. Is astrology a real science?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Our temperature zones are cause by the tilt of the earth's axis.
2. The seasons are caused by the tilt of our axis and the position of the earth in its orbit.
3. The sun is an average-size star.
4. The planets shine by reflected sunlight.
5. The planets vary in size and distance from the sun.
6. The planets and their satellites are held in their orbits by gravity and inertia.
7. The moon rises at a different time each day.
8. The tides are caused by the gravitational pull of the sun and the moon.

VOCABULARY

astrology
boundaries
direct
frigid zones
gravity
inclined
inertia
planetarium
reflect
slanting
temperature zones
tides
torrid zone
zodiac
zone

SCIENTISTS

Copernicus, Nicolaus
Galilei, Galileo
Lowell, Percival
Newton, Sir Isaac

Fourth Grade

f MATTER AND ENERGY

HEAT AND WORK

PURPOSE OF THE UNIT: ***to become aware of heat and work and to see how heat and work influence our lives***

Apparatus and materials

1. Burner (Bunsen, propane, or canned heat)
2. Cans, coffee
3. Conductometer
4. Cookie sheet
5. Cup hook
6. Dry cell
7. Glass tubes, 4 inches
8. Hot plate
9. Lumber, 2 inches x 4 inches, 6 inches long
10. Marbles
11. Margarine or shortening
12. Meterstick or yardstick
13. Nails, 4" common
14. Radiometer
15. Rubber bands
16. Sandpaper, one sheet
17. Simplified chart or model of gasoline engine
18. Spring balance
19. Wire, fine

INTRODUCTION OF THE UNIT

Motivating activities

1
Set up a bulletin board showing pictures of such things as a toaster, a campfire, an automobile engine, an electric blanket, a rocket, a kitchen stove, an outboard motor, a steel mill, and a welder. On a label ask: "In what way are all these things alike?" (They all use heat to accomplish their purpose.)

2
Have the children use the science table for a display of items that can produce heat. Such items as candles, light bulbs, matches, hot plates, and coal will be displayed. Some of the items will be useful later in the unit.

Motivating questions

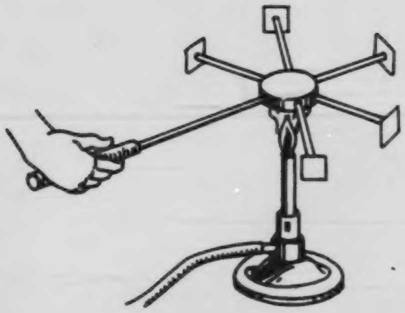
1. Ask pupils how they have made use of heat today, and where the heat came from. Examples: hot breakfast, warm water for washing, heated home, and heated school.
2. Why is oil put into the engine of an automobile?
3. What is a machine?
4. Why do we have machines?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
Develop a class discussion centering around the composition of our universe. What is the physical universe made of? There is matter, i.e., the material or elements of which all objects are formed. There is also energy, the capacity to move or change the physical objects. Point out that our universe (our world) is in constant motion. Ask the children for examples of movement (day and night, wind, running water, animal movement, plant growth, and mountain erosion). Matter, by itself, does not start moving or change. Energy must be applied to matter to cause it to change. Our universe is a collection of matter being affected by energy.

2
Using a simplified chart, point out that our automobiles, buses, and trucks are operated by heat engines. Without discussing the intricacies of an engine, point out that the hot gases from burning gasoline push down on the piston which is connected to the wheels and makes them turn. (A small model airplane engine can be used to depict the action of the piston).

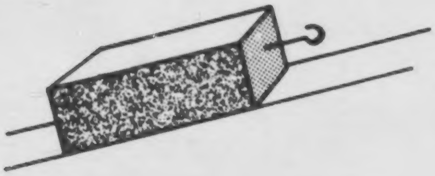


3
Heat energy can move from place to place. Materials through which heat flows readily are called conductors. Materials through which heat does not flow readily are called insulators. Using a heat conductivity demonstrator, or conductometer, demonstrate how several materials vary in their ability to conduct heat.

Squares of cardboard are held to the ends of rods with a drop of wax. Rods of different materials conduct heat at varying rates and the wax will melt at different times.

4
To demonstrate the effect of heat conductors and heat insulators, have a pupil hold one end of a 4-inch glass tube and one end of a 4-inch common nail in the flame of a burner. After a short time, the nail will get hot and have to be dropped. The glass, however, can be heated until its end melts without noticeable heat traveling down its length. Be sure to carry out this demonstration on a surface which

will not be damaged by the hot nail when it is dropped. Also, be very careful of the glass tube after it is heated. The heated end of the glass will remain extremely hot for quite awhile. Relate this idea of heat conductors and insulators to the wooden and plastic handles on pots, pans, and irons. (If the glass is hollow, avoid the flame traveling through it by holding it horizontally.)



5

To demonstrate that friction depends on the type of surface involved, obtain a 6 inch piece of 2 x 4 lumber, a cup hook, a cookie sheet, desk blotter, sheet of sandpaper, a thin rubber band, and a ruler. Screw the cup hook into the wooden block as illustrated. Attach the rubber band and measure how far it must be stretched in order to start the block sliding on the surfaces of a cookie sheet, blotter, and sandpaper.

6

To demonstrate that friction is related to the force applied, use the block and rubber band arrangement described in activity No. 5 or the block and spring balance. Use only one type of surface (perhaps a desk top) and measure the stretch in the rubber band or balance readings, necessary to start the block sliding as one, two, and three books are placed on top of the wood.

7

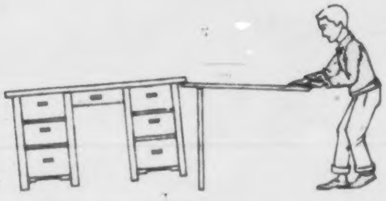
Lead a discussion about the causes and results of friction. Follow this with the question "How is friction useful to us?" Develop the concept that each time a car or bus starts driving down a road, it is the friction of the tire against the pavement that allows it to move. Did any pupil ever see a car on ice try to get started? How is friction useful in stopping a car? Why is it easier to walk on a dry sidewalk then on an icy one?

8

Rolling friction is generally less than sliding friction. Use a roller skate or toy wagon to move a pile of books. Then push the books along the surface of the desk. Note the great difference in effort required.

9

Connect a short piece of fine copper wire to each terminal of a dry cell. If it does not glow red hot, hold a piece of paper against it until the paper chars or burns. A thin strand of iron wire will also demonstrate the effect of electrical heating. Turn on a hot plate; and show heated coils as electricity passes through the wires.

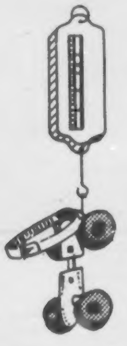


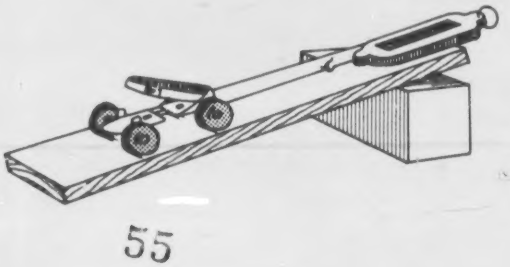
10

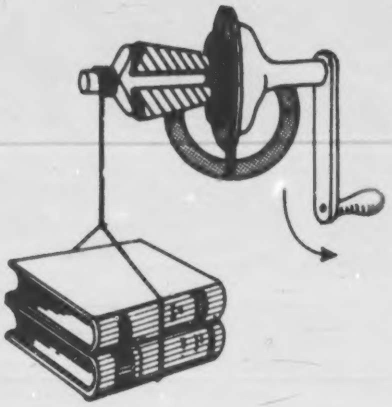
A common simple machine is the lever. With a lever, great weights can be lifted with little effort. Saw off a board so that it is the same height as a heavy desk or table in the classroom. Place another board about the same length on this and under the edge of the desk, as shown in the diagram. Note how little force is necessary to lift the heavy furniture. (Caution should be exercised to prevent the lever from slipping.)

11

To demonstrate the effect of the inclined plane, attach a spring balance to a roller skate. Note the force necessary to lift the skate vertically. Next pull the skate up an inclined plane and note the force necessary to raise it.







12
A pencil sharpener can be used to demonstrate the action of a wheel and axle.

Note: Care should be taken not to use the terms "force" and "work" interchangeably. The term "force" refers only to the strength of a push or pull (usually measured in pounds). The term "work" is used to describe the product of the force applied to a moving object multiplied by the distance it is moved. For example, a certain amount of "work" is required to lift a box from the floor up to a shelf. Whether or not a simple machine is used to lift the box, the "work" cannot be reduced. By using an inclined plane, it is possible to reduce only the "force" necessary to raise the box. But this reduced "force" will have to be exerted over a greater distance (along the incline rather than straight up) so the "work" done will not be less.

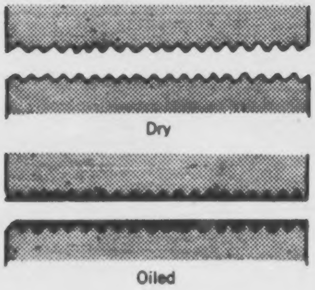
Remove the cover from a pencil sharpener and tie a strong string tightly around the end of the shaft. Tie a weight of several pounds to the other end of the string and turn the handle. Point out that the handle is equivalent to one spoke of a wheel as it turns around, and the shaft is an axle.

Activities for children

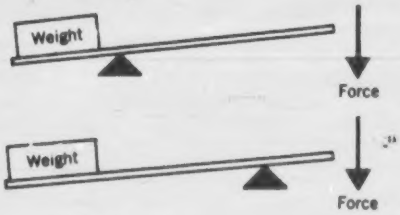
1
Divide the class into small groups and have each group compile a list of as many uses of heat as they can. Later combine the lists. It may be interesting to separate the list into categories such as uses of heat at home, in school, in industry, and for sports.

2
Friction is one source of heat. Rub palms of hands together. How does the heat produced vary with how hard the hands are pressed together?

3
Slide a chair across the floor of the room. Repeat with a pupil, or the teacher, in the chair. How does friction vary with pressure between the two sliding surfaces?



4
Based on activities 5 and 6 under "Teacher-directed activities," it can be generalized that the greater the friction, the greater the effort necessary to produce motion; therefore, in order to make machines move more easily we lubricate them to reduce friction. Have each child press his index finger firmly on a sheet of paper and then slide his finger along. Next rub some margarine or shortening on the paper and have the children slide their fingers over the greasy surface to note the lubricating effect. All surfaces are irregular. The use of a lubricant tends to fill the "valleys," as illustrated.



5
Using a meterstick or yardstick for a lever and a chalkboard eraser for a fulcrum, lift a book. Vary the position of the fulcrum and note how the effort needed to lift the book changes. Have pupils determine the relationship between the position of the fulcrum and the effort needed to lift the book.

Fieldwork

1
Visit the high school industrial arts shop to see the operation of a brake drum. Ask the automobile instructor to point out a few places in an automobile where lubrication is used to reduce friction.

2
If any large excavation work or building construction is taking place near the school, watch the cranes and other large machinery. How long would it take to do the same job without machines?

ENRICHMENT

Questions to stimulate further thought

1. What would happen if suddenly there were no more friction?
2. Petroleum products have only been available for approximately 100 years. How did people before this grease the wheels of their machinery?
3. Why and how are our homes insulated?
4. What special shoes are worn when playing baseball, football, basketball, and golf? Why are these shoes made this way?

Topics for additional exploration

1

Radiometer. Set a radiometer in direct sunlight. Allow children to speculate on its operation. What else besides light is falling on the vanes? (Heat.) How can we discover which type of energy, light, or heat, is responsible for the observed motion?

2

Heat bills. Find the number of gallons of fuel oil (or cubic feet of gas) used by the school each year to heat the building. Multiply this amount by the average cost of fuel to find the approximate heating bill for the school. Perhaps some child may wish to volunteer to find out what his annual home-heating bill is.

3

Bearings. Another method of reducing friction between two moving surfaces is by using bearings. There are numerous types of bearings. A striking example of how effective ballbearings are can be shown by placing a coffee can upside down on a table and placing marbles so that they form a circle around the rim. Place a second coffee can rightside up on top of the marble bearings. Turn the top can and note how easily it rolls around on the bearings.

4

Simple machines. The wheel, the lever, the inclined plane, the wedge, the pulley, and the screw are considered to be simple machines. The most complex machines are only combinations of these simple devices.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1

Make a display of various heat insulators and heat conductors and show how they are used.

2

Make a mural showing how people have used fire or heat since the time of the cavemen.

3

Make a model steam turbine. A large cork or a cylindrical piece of wood can be used for the rotor. The bearing can be improved by sharpening the point of the finishing nail and fusing the end of the glass tube until it is well rounded. The vanes may be penpoints or similarly shaped pieces of metal cut from a tin can. The nozzle should not be smaller than $\frac{1}{16}$ inch and the stopper should not be pressed in too tightly. In the interest of safety, keep pupils some distance away from the apparatus when it is operating. Children should be cautioned about the hazards of experimenting at home.

Questions to guide a summary of experiences

1. What is heat?
2. How do we produce heat?
3. How do we use heat?
4. What materials are the best heat conductors?
5. When is friction not wanted?
6. When is friction useful?
7. What are some examples of some simple machines?
8. Why do we use simple machines?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Heat is a form of energy.
2. Heat energy is used to run many machines.
3. Heat is produced by fire, friction, and electricity.
4. Metals are good conductors of heat, wood is a poor heat conductor.
5. Heat from friction is wasted energy.
6. Friction makes it difficult to slide one object along another.
7. Friction is reduced by the use of bearings and lubrication.
8. Friction is useful in stopping moving things.
9. Machines are used to make work easier.

VOCABULARY

bearings
conductor
effort
energy
friction
fulcrum
heat
insulator
lubricate
matter

SCIENTISTS

Joule, James
Thompson, Benjamin

Fifth Grade

a LIVING THINGS

b OUR GROWING BODIES

c AIR, WATER, AND WEATHER

d THE EARTH AND ITS COMPOSITION

e THE SOLAR SYSTEM AND BEYOND

f MATTER AND ENERGY

Fifth Grade

a LIVING THINGS

THE WAYS LIVING THINGS FUNCTION

PURPOSE OF THE UNIT: ***to become aware of some of the ways in which living things function***

Apparatus and materials

1. Aquarium
2. Beakers
3. Dragonfly nymph
4. Elodea
5. Fixative or shellac
6. Frog
7. Glass jars
8. Goldfish or native fish
9. Houseplants
10. Iodine or ink
11. Lichen plant
12. Microprojector
13. Microscopes
14. Onion
15. Pictures of cells (magnified)
16. Plaster of paris
17. Plastic clay
18. Potatoes
19. Prepared slides
20. Seeds (radish, bean)
21. Shoe box
22. Terrarium
23. Vaseline

Note: During this unit of work it is most desirable to have some magnifying devices other than simple hand lenses. Microscopes are difficult for children to use and accidental damage can be very expensive. For this reason a good microprojector which has various magnifications and a strong light source is a highly desirable piece of equipment. When a microprojector is used, the teacher is able to direct the children's attention to any specific part of the projected image and all the children can view the image simultaneously. In this way a lesson can be reinforced by viewing the object under study as it is discussed.

INTRODUCTION OF THE UNIT

Motivating activities

1
Make a "What Is It?" display of a picture or photograph showing a microorganism such as a paramecium or an amoeba. Place a reference book containing an identifying picture of the organism with this display.

2
Collect some pictures of cells which have been taken under magnification and arrange them as a bulletin board display. A good source is a discarded catalog from one of the biological supply houses.

3
Set up a microscope with a prepared slide showing the cross section of a woody stem or make a temporary slide of a human hair. Set the microscope so that either of these may be seen under low power magnification (100x). Place a card next to the instrument which reads "What do you see?"

4
Arrange a bulletin board display of a food pyramid which illustrates the idea of food chains. The base of the pyramid is always one or more green plants because green plants are the primary sources of food supply for all living things. Animals that feed directly on green plants may be shown in the center of the pyramid; the predators that feed on these animals are at the top of the pyramid. Such a pyramid display can be made using pictures of plants and animals.

5
Set up an aquarium stocked with some water plants and fish (goldfish, tropical, and native fish).

6
Bring in some houseplants, strip off a bit of the skin of a leaf from one of them; make a temporary microscope wet mount, and let the children see the cells. The houseplants may also be used for future classroom experiences related to this unit.

7
Display a small collection of fungi as examples of plants which do not produce their own food. "These plants are not green. How, then, do they get their food?"

8
Use a specimen of a lichen plant for a "What Is It?" exhibit. Supply a book which the children can use as a reference.

Motivating questions

1. Of what are living things composed?
2. What are the smallest living things?
3. What makes some plants green?
4. How are green plants important to living things?
5. What happens to the food which is eaten by animals?
6. How is blood important to animals?
7. When we eat, how do we make use of the sun's energy which has been stored in plants?

EXPERIENCES RELATING TO THE UNIT

Note: Viruses may be mentioned by a pupil. Viruses are difficult to discuss at this level because of the limited scope of the children. Viruses do have the ability to reproduce themselves and grow, yet they are not composed of cells and they do not fit nicely into any classification of living things. They are neither plant nor animal.

Teacher-directed activities

1
The different kinds of cells and their structures, as well as the variety of one-celled animals, probably can best be shown to the whole group with a microprojector. After the class has had the opportunity to view a selection of prepared slides, it may be possible for them to examine the slides again in small groups with a microscope.

2
The children can view the tiny one-celled animals which are found in a drop of water. Collect some water from the edge of a pond or from the classroom aquarium if it contains pond water. Place a drop of water on the slide under the microprojector. Notice the variety of one-celled organisms. Make note of their shapes and movement. Occasionally you may see some higher organisms, such as daphnia, cyclops, and hydra.

Note: When pointing out microorganisms, teach pupils to refer to their position in the field of view by reference to the numbers on the face of a clock. An object at the right of center would thus be at 3 o'clock, and one a little lower would be at 4 o'clock.

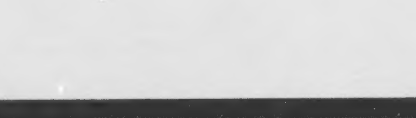
3
Collect some algae (pond scum) from a pond or pool and examine it under the microprojector. The divisions between cells can be seen quite clearly. The green coils within the cells contain chlorophyll, which aids in the manufacture of food.

4
Your water-drop collections may contain one-celled plants (algae) of interesting shapes called diatoms. They are sometimes green, but may be a golden brown color. Their shells exhibit beautiful and intricate designs.

5
Select prepared slides of plant tissues which show cell structure very clearly. Examine these with the class by using a microprojector.

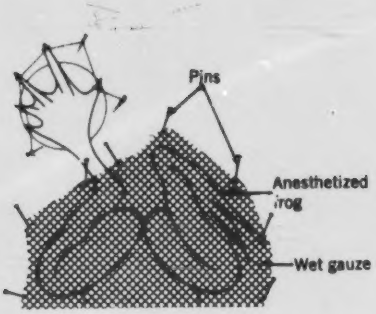
6
Select prepared slides that clearly show the cell structure of tissues. Choose some which show nerve, muscle, blood, and skin. Human tissues will be particularly interesting. These must be examined under high power to reveal the cell structure.

7
There are several simple ways to prepare microprojector demonstrations showing the circulation of blood through the capillaries of an animal. Extreme care must be taken to preclude injury to the specimens.



Goldfish tail: Wet a microscope slide and a 2-foot length of gauze bandage. Carefully lift a small goldfish from water; lay it on the wet microscope slide so that its tail is near the center of the slide. Wrap the fish to the slide with the wet gauze. Place the slide with the fish on the stage of the microprojector and observe the tail under low power. Look for the larger blood vessels which run parallel to the rays in the fish's tail. The capillaries are much smaller and connect these larger blood vessels. Note the blood cells as they move along the larger vessels, then into the capillaries. It will be necessary to focus sharply to see the walls of the capillaries as they are very thin. Keep the tail wet with water, using a dropper or your fingers dipped in water. Occasionally pour a little water on the gauze over the head of the fish. Watch for signs of slowing of the circulation. When the blood is moving noticeably slower, remove the fish from the slide and replace in the water for a few minutes. It may then be replaced on the slide for further observation. The brick-like structure you observe are blocks of cartilage that make up the skeleton of the fish's tail, something like the bones of a human finger. When you are finished with the fish, return it to its tank. If it moves very slowly, pick it up by the tail and dip it in and out of the water. This helps to increase the supply of air in the water near the gills.

Tadpole tail: If small, freshly hatched, frog or salamander tadpoles are available, place one on a depression microscope slide (well slide) in a few drops of water. Add a cover glass to restrain its movements and examine under low power. Corpuscles moving through capillaries of the frog's tail and through the salamander's gills can be plainly seen. Careful focusing is necessary to see the thin, delicate walls of the capillaries.



Frog's foot: The skin in the web of a frog's hind foot has an abundant supply of capillaries. The frog will have to be placed on a thin piece of wood, such as balsa wood, a wooden shingle, or a slat from a vegetable box. Cut a half-inch hole near one end of the wood. Soak the wood in water at room temperature. Lay the frog on the board; wrap the body and outstretched legs to the wood with moist gauze. Spread one foot over the opening, and hold it in place with thumbtacks pinned to the board around the edge of the foot (but not to the frog). Clip the piece of wood to the stage of the microprojector or hold it in place with a rubber band. Examine under low and high power.

8
Show films and filmstrips which describe the oxygen-carbon dioxide cycle in animals and plants. The digestion of food, its absorption and circulation can probably be experienced best through the use of visual aids.

9
Elodea is one of the most satisfactory of aquarium plants for microscopic examinations. This plant can be obtained from an aquarium shop or collected from a pond. The tips of the leaves will provide a good demonstration of cell structure. Cut off a small section of a leaf tip. Mount this section in a drop of water, and observe it under a compound microscope or a microprojector adjusted to a high power. Observe the structure of the cells and note the colored chloroplasts (chlorophyll bodies). All pupils should have this experience as a means of reinforcing their understanding of food manufacture by green leaves. The tiny dots of coloring matter are the substances which unite the carbon dioxide (CO_2) and water (H_2O) to form carbohydrates (sugars and starches).

Activities for children

1
The prepared slides of plant and animal tissues which were shown by the teacher may be examined by the children with a compound microscope. Note the difference between plant and animal cells. There are many different kinds of animal cells.

2
The most satisfactory approach to the world of tiny plants and animals is through firsthand observations. Hay or grass infusions (from a low wet place) provide suitable cultures for such observation. To start an infusion, place a handful of dried grass or weeds in a glass jar or other vessel and fill the vessel with water. Each pupil or groups of pupils might start such an infusion, which should be teeming with microscopic life within a week or less. In such infusions, microorganisms will usually be concentrated near the surface. A medicine dropper is a convenient way to transfer drops of this surface liquid to the slide for observation. A microprojector, rather than a microscope, will allow the enti[illegible]lass to observe these microscopic organisms easily and efficiently.

3
Prepare three infusions as described in the previous experience, using similar jars and equal amounts of dried grass and water from the same sources. Place one in a sunny place, one in a well-lighted shady place, and one in the dark. Compare the microscopic life found in the three infusions at the end of a week.

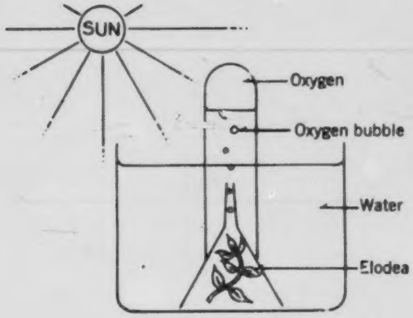
4
Collect a few pieces of bark which show a decided greenish color from the shady side of a tree. Soak the bark in water for an hour; carefully transfer a bit of the green material onto a slide. Place a drop of water on the specimen and cover it with a cover glass. The green oval cells observed are those of a common alga called Protococcus. Look for single cells as well as groups that are in process of dividing.

5
Strip off one or more of the fleshy leaf bases from an onion. Remove a piece of the thin skin from the inner surface of one of these leaves. Mount this piece of tissue on a microscope slide and examine it under the microscope. The cellular structure of the onion should show up very clearly and will resemble tiny boxes. Add a small amount of dilute iodine solution or blue fountain pen ink to the tissue. This will stain the cells and make them stand out more clearly. Compare the stained slide with the original one.

6
Rub the leaf of a tender-leaved plant, such as the common plantain, between the fingers to loosen the tissues. Peel off a thin piece of the outer layer from the bottom of the leaf. Place this bit carefully on a microscope slide with a drop of water and a cover glass. The little mouth-shaped structures called stomates are openings which admit air to the leaf, give off water vapor, give off oxygen as a product of photosynthesis, and give off carbon dioxide during the hours of darkness.

7
Examine some skin cells under the microscope. These can be scraped off the palm of the hand with the edge of a knife blade. Put some of the material on a slide; stain it with a dilute solution of iodine and water or fountain pen ink, and cover it with a slide cover.

8
Scrape some skin cells from the inside of the cheek with a toothpick. Place this material on a slide, stain it with a drop of ink, then cover it with a slide cover and examine. The nucleus, a dark spot, can be noticed within each cell. Is there a similarity to the cells scraped from your hand?



9
The release of oxygen into the air cannot, of course, be observed from most plants, but it can easily be observed in certain water plants, such as the common aquarium plant, Elodea. Cut two or more tips of Elodea 2 to 6 inches long, and place them in a jar or beaker of water, tips down, in bright sunlight. Tiny bubbles which are mostly oxygen can be seen coming from the cut stems. Hold a card in front of the beaker containing the Elodea tips so as to cut off the light. Bubbles are no longer seen. Remove the card and they begin again.

10
Using a prepared slide, examine the cross section of a leaf. Locate the stomates (mouth-shaped structures) through which gases enter or leave the plant. Locate a vein through which liquids move through the leaf. Find the cells which make the food. Thin sections of roots and stems may be studied also.

11
The leaves of green plants arrange themselves so they are in a favorable position relative to sunlight. In order that plants may carry on photosynthesis, their leaves must be in a position to receive light. Plant fast-growing seeds, such as oats, radish, or bean seeds, in two pots or shallow containers. When the seedlings are an inch high, cover one container with a box having a hole on one side. Lift the box from day to day; note the direction of growth.

12
Cut a 2-inch hole in one end of a shoe box. Place a sprouting potato in a pot of soil at the other end of the shoe box, and put the box where it will receive plenty of light. The cover may be removed for short periods to observe plant growth or to water the plant.

13
The leafy houseplants which are in the room show a change in direction of growth. This will be more noticeable if the plants are not turned, but left so that the light always shines on the same side of them.

14
Plant fast-growing seeds such as radish, bean, or sunflower, in a flowerpot and keep it in the dark. Notice how rapidly these seedlings grow. How long will they live in a dark place?

15
Certain chemical changes are brought about by light energy from the sun. There may be a bulletin board in the room which receives light from the sun. The next time the display is changed, look at the colored paper which served as a background for the display. Notice a difference in the color, because the area which was covered will be the original color while the surface which was exposed to the sunlight is faded. A similar demonstration can be made by placing a piece of colored paper in a sunny place such as a window ledge. Cover part of the paper with a book or another opaque object. Check this each day by lifting the covering and replacing it in the exact same place. How long does it take before fading begins to show? The light energy from the sun causes a chemical change in the paper, which we call fading.

16
The breathing mechanisms of fish can be observed in a classroom aquarium. Watch the mouth and gill-cover movements of the fish. Note that as the mouth is opened to admit water, the gill covers close. The mouth is then closed and the water is forced over the gills, and out through the gill covers, which are now open. Fish receive oxygen from the water and require a continuous flow of water over the gills. The gills appear bright red because of the large number of capillaries in them. This brings the blood into close contact with the water over a large surface. The oxygen in the water is absorbed by the blood and circulated through the body. As the blood circulates through the gills, it releases carbon dioxide into the water.

17
The breathing of frogs can be observed in a terrarium or other clear glass container. The pulsating movement of a frog's throat can be observed while it is at rest. When the frog lowers the bottom of the mouth with the mouth closed, air is drawn into the mouth through the open nostrils. As the floor of the mouth rises, the nostrils are closed by flaps of skin and air is forced into the lungs. We can breathe with our mouths open or closed, but frogs and toads can breathe only with their mouths closed. Our ribs and diaphragm help us to breathe and since frogs lack these, the muscles of their mouths must do the work.

20
Collect a dragonfly nymph from a pond or stream. Put it in a shallow plate or pan of clean water and, when the water is quiet, deposit one drop of ink near its tail. Watch how the dragonfly nymph squirts water from the top of its abdomen and makes " ink rings " in the water. It does this as it exhales, since its gills are inside its abdomen.

Fieldwork

1
Visit the office of a veterinarian. Usually he will have a supply of prepared microscope slides showing various kinds of animal tissue. He may show the group his method of preparing the slides. He can tell how he uses the slides to help him care for the animals.

2
Most hospitals are equipped with laboratories where human blood cells and tissues are analyzed. These laboratories will have special instruments which help them prepare slides; perhaps they will exhibit some prepared slides which are used by doctors to diagnose diseases. Children will see special optical aids which are used to examine their slides; and perhaps a demonstration of a blood test.

3
Field trips may be undertaken to collect material to be examined in the classroom. The class can make short trips near the school to collect some leaves, plant stems, algae from tree bark, or pond water.

4
When the leaves have begun to change color in the fall, take a trip to collect and examine some of these leaves. Note the variations in the color of the leaves. Some leaves will still show some green coloring matter (chlorophyll), while at the same time exhibiting other colors. Where were the yellow, orange, and red leaf colors during the summer? Take some of these back to the classroom to examine under the microscope. Look closely at the point where the stem of the leaf joins the supporting branch. Can the leaf be easily removed from the branch?

ENRICHMENT

Questions to stimulate further thought

1. How long can a man go without food? Without water?
2. How does a tree survive the long cold winter without leaves to help in the food-making process?
3. If amphibians and some reptiles, such as turtles, breathe air by means of lungs, how are they able to obtain oxygen while they are hibernating in mud under water?
4. The fall colors of trees in the temperate climate of the northeast are one of the wonders of nature. What causes this change? Where were the colors during the summer months when the leaves were green?
5. Is it possible for a fish to drown in water?
6. Why are stomates found on the underside of leaves of most plants? Are there any plants which have stomates on the topside of the leaf?
7. What would happen if plants didn't replenish the atmosphere's oxygen?
8. If birds do not have any teeth, how do they break up their food for digestion?

Topics for additional exploration

1
Hibernation. Many animals hibernate during the cold winter months. The ways in which these animals prepare for hibernation and their bodies function during this state are very interesting.

2
Root absorption. Although green plants manufacture their food (sugar) by photosynthesis, they take in minerals and water through their roots. Only dissolved materials can pass through the membrane of the roots in the plant. Note: Very often the terms " osmosis " and " diffusion " are used when various life functions are being discussed. Although the children may not be required to develop the finer biological understandings, it is well that the teacher understands such scientific terms so he will use them correctly. " Diffusion " refers to the process in which molecules of one substance spread through another substance. Perfume diffuses through the air. Dissolved minerals diffuse into roots. " Osmosis " is a particular kind of diffusion. It refers to the passage of water through a membrane. If in doubt, the teacher can always use the term " diffusion," since it is the more general all-inclusive term.

3
Digestion. Animals, including people, take food into their bloodstream by diffusion. We digest our food to make it soluble. Once dissolved, it can diffuse from our intestines into the blood where it is distributed to all parts of the body. Material which we eat that is not soluble will not diffuse into the bloodstream, and passes through the digestive tract as waste.

4
Food oxidation. The blood also carries oxygen to the cells. The oxygen from the air diffuses through the very thin lung tissue into the bloodstream. It is in the individual cells of the body that the food is oxidized to produce the energy for life.

5
Controlling disease. Many diseases are caused by microscopic plants and/or animals. A common method of controlling these disease-causing organisms is to change the environment so that conditions become unfavorable for their growth. This may be done outside the body with disinfectants, and inside the body with antibiotics.

6
Useful microorganisms. All microorganisms are not harmful to man. The clover plant and other legumes have tiny nodules of nitrogen-fixing bacteria attached to their roots, which are important in their function to return nitrogen to the soil. These nodules can be seen on the roots of a clover plant. Yeast and other bacteria play an important part in the production of such products as bread, cheese, vinegar, and leather.

7
Animal sensibility. Animals react to changes within their environment. They are sensitive to temperature changes, light, sounds, and obstacles. Many animals have certain sensory organs which help them as they move about in search of food, such as the antennae of insects and snails, the tongue of the snake, and the whiskers of some mammals.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make sketches of the single-celled plants and animals which are viewed under the microscope and microprojector. Include some under both low and high power.

2
Make labeled drawings of the cellular structure of living things observed under magnification; include the colored chloroplasts of green plants. Sketch a variety of animal cells, and color them accordingly.

3
Make models of one-celled animals from plastic clay. Different colors of the clay can be used to represent parts of the animals. Models of blood cells can also be made.

4
Plaster of paris models of one-celled living things can be made and painted. Obtain a piece of glass or other smooth surfaced material. Using this as a base, make an outline of the animal or plant from plastic clay to serve as a mold. Coat the inside surface of the mold with vaseline or liquid green soap, so that the mold can be easily removed. Mix the plaster of paris and pour it into the mold. When it has hardened, remove it and paint on parts or other features. Any external features can be simulated with string, wire, or other material. Spray the finished product with a fixative such as clear plastic spray, coat it with clear fingernail polish or shellac.

5
Using reference books, look up information about sulfa drugs and various antibiotics. A chart can be made which illustrates the sources of these drugs and how they are used to combat disease and infection.

6
Make a schematic diagram which shows the process of photosynthesis.

7
Make a large diagram of a cross section of a leaf as viewed under magnification, and color it accordingly.

8
Make a large chart which illustrates the carbon dioxide-oxygen cycle in nature.

Questions to guide a summary of experiences

1. What is the carbon dioxide-oxygen cycle?
2. Why is it necessary for animals to digest their food?
3. Of what are living things composed?
4. What are cells? What is their function? Are there many kinds?
5. What are some living things composed of only one cell?
6. How do green plants make their food? What things are needed?
7. What is a food chain? What is the primary source of food?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Animals require oxygen from the air; they give off carbon dioxide.
2. Animals digest their food so that it can be absorbed and circulated to all parts of their bodies.
3. Animals are composed of cells.
4. The cells use food and oxygen to produce energy for growth and movement.
5. There are many different kinds of animal cells: nerve, muscle, blood, bone, and skin are the most common.
6. The smallest animals are composed of a single cell, while larger animals are composed of millions of cells.

7. Plants are composed of cells.
8. Green plants can produce their own food by the process of photosynthesis.
9. Green plants combine carbon dioxide with water to produce their food (sugar).
10. Sunlight provides the energy for the process of photosynthesis.
11. Green plants are the first link in any food chain.

VOCABULARY

absorbed
algae
amoeba
capillaries
carbon dioxide
cells
chlorophyll
circulated
corpuscles
diffusion
energy
food chain
magnified
microorganism
microprojector
nucleus
paramecium
photosynthesis

Fifth Grade

b OUR GROWING BODIES

WOUNDS AND BLEEDING

PURPOSE OF THE UNIT: ***to learn how and why we protect wounds from contamination and control bleeding***

Apparatus and materials

1. Agar plates and covers, four
2. Alcohol
3. Anatomical chart or model
4. Band-Aids
5. Cloth band for tourniquet
6. Cotton balls
7. Gauze squares, 2 inches x 2 inches and 3 inches x 3 inches, sterile
8. Ice cubes
9. Microscope or microprojector
10. Potatoes or apples, four
11. Slides of whole blood, white blood cells, red blood cells, and blood platelets
12. Soap, liquid or bar
13. Sterile needle
14. Water

INTRODUCTION OF THE UNIT

Motivating activities

1
Have the pupils bring to class newspaper clippings which tell about accident cases that involve severe bleeding.

2
The pupils may write a short story about an incident in their lives which involved an infected cut. Such a topic might be " A cut that became infected."

3
The pupils may read stories about doctors and nurses preparing for an operation. The emphasis will be on cleanliness to avoid infection.

4
The American Red Cross can provide a short movie on the control of bleeding and the care of wounds.

Motivating questions

1. What is a wound?
2. Do all wounds bleed to the same extent?
3. When there is bleeding, is there always a wound?
4. Do all living things bleed on occasion?
5. Why do we have to control (stop) bleeding?
6. What do we mean when we say, " The cut is infected"?
7. Which is easier, preventing or curing an infection?
8. Why doesn't every cut or scratch become infected?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
From a chart provided by the American Red Cross, or from the nurse-teacher in your school, show the pupils the various types of wounds and explain the characteristics of each.

2
Using agar plates which can be obtained from the high school biology teacher, allow children:

a. To touch one plate with fingertips.
b. To touch one plate with fingertips that have been made obviously dirty by wiping them on the floor.
c. Have one child touch the plate with his fingertips immediately after washing his hands thoroughly with soap and hot water and drying them carefully on a clean paper towel.

Put the agar plates in an incubator or keep in some spot in the classroom where the temperature is warm and reasonably constant. The results should show rather dramatically the results of uncleanliness.

3
Using a microscope or microprojector and a prepared slide of a blood sample, the children will see various types of blood cells. Another slide may show only white blood cells, or red blood cells, or blood platelets. The function of each type in combating infection or in blood-clot formation may be explained.

4
Children at this grade level will already have seen small microscopic organisms in a drop of water. Bacteria, both harmless and harmful, can readily be explained within this context, if not already understood by the pupils.

5
One pupil may volunteer to have the nurse-teacher of the school, who has been invited in for the occasion, prick his finger and take a drop of blood. The nurse will explain the procedure as she does it; wiping the finger with alcohol, sterilizing the needle, and finally pressure on the needle prick with a pledget of cotton which has been saturated with alcohol. This illustrates many of the recommended procedures in controlling bleeding (pressure) and avoiding contamination (use of alcohol).

6
The school nurse-teacher or the classroom teacher may demonstrate for the class the proper method of cleansing a wound: washing away from the edges of the wound with a sterilized piece of gauze, soap, and water.

Activities for children

1
Children may practice washing an imaginary cut, using the technique already described and demonstrated.

2
Children may stand with one hand over their heads, the other one at their sides. After 15–20 seconds, they may then compare the color of their two hands. This illustrates the use and value of elevation in the control of severe bleeding.

3
Pupils may be taught how to take each other's pulse. By pressure on the inside of the upper arm, the pulse may be made to disappear. This illustrates a different kind of pressure in the control of bleeding. The brachial artery pressure point can be used to stop arterial bleeding in the arm and hand below this point.

4
Pupils may soak one hand in ice water, while the other hand is in normal room atmosphere. The whiteness of the immersed hand is due to a diminished blood flow, and is illustrative of one more means of controlling bleeding — the use of cold.

5
Give each pupil either a Band-Aid or a 2 inch x 2 inch or 3 inch x 3 inch sterilized, cellophane wrapped, gauze square. Demonstrate the method of opening and applying each to a wound, so the sterile gauze is not contaminated by touching any other object before being applied to the wound.

Fieldwork

1
Pupils may get from the nurse-teacher the statistics on the number of wounds she treated during a given three- or four-week period. The number that became infected after the first aid care by the nurse-teacher would make this exercise an interesting one.

2
A trip to the local fire or ambulance company will afford an opportunity for the children to see the type of equipment carried by these units to help them handle bleeding emergencies.

ENRICHMENT

Questions to stimulate further thought

1. What is the difference between arterial blood flow and venous blood flow?
2. Can we administer first aid to ourselves?
3. What is even better than knowing how and when to apply first aid?
4. Are there some people in whom it is impossible, or nearly so, to stop bleeding?
5. How can a cut cleanse itself?

6. What kind of a wound is most likely to become infected? Why?
7. How can we help our body avoid infection when we are wounded?
8. Can you give any examples of internal bleeding?

Topics for additional exploration

1
The circulation of blood. A chart or model of a human being will show how blood circulates. It may be important to point out to pupils that the large arteries are generally deep in the body, veins and small blood vessels nearer the surface. This is nature's method of protecting us from serious bleeding.

2
The use of a tourniquet. Pupils may be shown how a tourniquet may be applied to either upper or lower extremity. *Extreme caution must be used in this instruction, however, to be sure the children understand the dangers inherent in its use.* It is used as a last resort after every other method to stop the bleeding has failed. Only a doctor should remove the tourniquet when one is applied.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Write on the blackboard the description of a wound. Have the pupils write out, in sequence, the steps they would take in caring for the wound.

2
With one person acting as the victim or patient and another as the first aider, let them give an actual demonstration of how a wound should be cared for properly. When they are finished, let the rest of the class offer suggestions as to how it might have been done better.

3
Have the class prepare a bulletin board display showing the various types of wounds and the things which may cause each of the types.

4
Have each child write a short story about " The Cut That Became Infected "; " The Cut That Wouldn't Stop Bleeding," or some similar topic where both imagination and factual information can be used.

Questions to guide a summary of experiences

1. What is the difference between " bleeding " and " serious bleeding "?
2. Name the four kinds of wounds. What is apt to cause each kind?
3. What are three ways we can help the body stop bleeding from a wound?
4. How do germs get into a wound?
5. What causes the infection of a wound?
6. How can we help prevent infection?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. A wound is any break in the skin.
2. The body has ways of controlling bleeding, but often it is best if we assist.
3. Bacteria are all around us and they can enter the body through any break in the skin. Cleanliness is very necessary to avoid infection in a wound.

4. Even a clean cloth may have bacteria on it. We should cover cuts with sterile cloth if possible. This allows no dirt or bacteria to enter the body.
5. Whenever a blood vessel is cut, bleeding will occur. The amount of bleeding depends on the number and size of the vessels cut.

VOCABULARY

abrasion
agar
bacteria
clot
contaminate
elevation
incised
incubator
infection
laceration
microscope
platelet
pledget
pressure
punctured
tourniquet

SCIENTISTS

Cannon, Walter B.
Smith, Theobald

Fifth Grade

C AIR, WATER, AND WEATHER

AIR AND ATMOSPHERE

PURPOSE OF THE UNIT: ***to discover some of the characteristics of air pressure, of moving air, and of the atmosphere***

Apparatus and materials

1. Balance
2. Ball, Ping-Pong
3. Basketball
4. Bottle, quart, milk
5. Can, gallon, with screw top
6. Candles
7. Eggs, hard-boiled
8. Hot plate
9. Jar, large, glass
10. Needle valve
11. Pan, shallow
12. Pins
13. Plunger, sink
14. Projector, overhead
15. Pump, bicycle
16. Pump, vacuum
17. Steel wool
18. Straws, drinking
19. Test tubes
20. Thread
21. Tumblers, water
22. Vacuum cleaner
23. Weight-of-air cylinder

INTRODUCTION OF THE UNIT

Motivating activities

1
Provide a shelled hard-boiled egg and a quart milk bottle. Ask for a volunteer to push the egg into the bottle. The bottle is full of air; because pressure is not evenly distributed over the egg, the egg can't be pushed into the bottle. Perhaps some of the pupils will know that the egg can be forced into the bottle by atmospheric pressure, if some of the air in the bottle is first removed. To do this, drop a piece of burning paper into the bottle and immediately place the hard-boiled egg on the mouth of the bottle. The flame consumes part of the air in the bottle (the oxygen) and, the heat expands the air to drive some of it out of the bottle. The air pressure on the outside then pushes the egg into the bottle, to fill the partial vacuum which has been created. Ask the children why the egg " popped " into the bottle. Air pressure can be used to remove the egg from the bottle by blowing into it while the bottom is elevated.

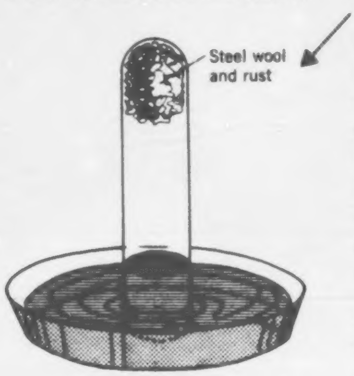
Motivating questions

1. Can an airplane fly to the moon? Why?
2. How far above the earth's surface does the atmosphere extend?
3. Why are satellites placed in orbits at such great distances from the earth?
4. If you place two cans close together on drinking straws arranged to form rollers so the cans move easily and blow between them, what will happen? Will the cans be pushed apart or together?
5. Why is a pneumatic lift able to raise a car off the ground?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
To demonstrate that air is composed of more than one gas, remove oxygen from a sample of air and show that about four-fifths of the air still remains. To do this, push a wad of wet steel wool into the bottom of a test tube. Prior to this, the steel wool should have been washed in detergent to remove the oil which was put on it to keep it from rusting. Invert the test tube in a shallow pan of water, as shown in the diagram, and have the children observe it occasionally for the next few days. As the oxygen begins to combine with the steel wool to form rust, the water will rise in the test tube to take its place. After the water has risen about one-fifth of the way up the tube, no further change will occur, because the oxygen will have been exhausted, leaving only the other gases which are in the air.



2
Carefully weigh a deflated basketball. Record this weight. Inflate the ball until firm. Reweigh. How much heavier is it now? What caused this change in weight?

3
To accurately determine the weight of air, it is necessary to borrow some apparatus from a high school science laboratory. With a sensitive balance, a vacuum pump, and a weight-of-air cylinder, a most interesting demonstration can be performed. Remove the air from the cylinder with the vacuum pump. Close the stopcock on the cylinder and weigh the cylinder as carefully as possible on the balance. This reading will be the weight of the can with no air in it. When the class is quiet, slowly open the stopcock and the children will hear the air rushing in to fill the vacuum. Reweigh the cylinder to find the weight of the cylinder plus the air in it. Subtract the first weight from the second to calculate the weight of the air in the cylinder.

4

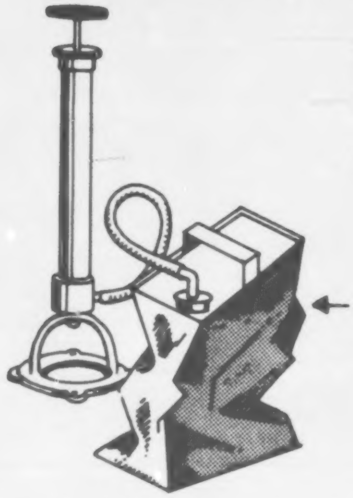
Ask the children if they can think of any methods of demonstration showing that air takes up space. See " Air, Water, and Weather " units for First and Third Grades. When a pupil suggests a valid demonstration, invite him to use the material you have to show his suggestion to the class. Be sure that the pupils involved explain what they are doing and why.

5

Through a discussion, and with the aid of charts or diagrams, develop the understanding that we live at the bottom of an ocean of air. This ocean of air is about 300 miles deep and we depend on it in many ways. Because the air extends so far above us and because air has weight, it is constantly pressing down on us. This atmospheric pressure is not usually noticed, because most objects have inner pressure approximately the same as the ocean of air surrounding them. Some of the pupils will have experienced a change in this pressure during mountain trips. Have them describe the sensation of being a mile or more above sea level.

6

Show the children an aneroid barometer. Explain the basic principle of its operation. Have the children note and record the air pressure. Take later readings at various times during the next few days. Record each of these readings. Have the children attempt to explain why the air pressure varies from time to time.



7

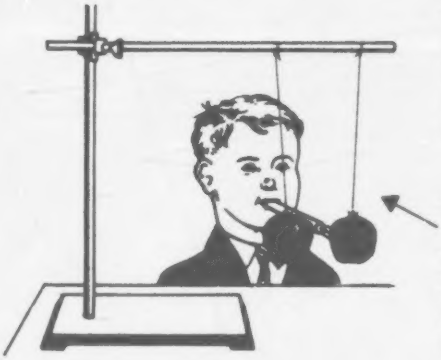
The pressure of air can be used to crush a varnish or maple syrup can. Any flatsided can with a capacity of at least a gallon will do.

a. Be sure that the can has a tight fitting stopper or screw cap. Boil a small amount of water in the open can for a few minutes. Remove the can from the heat and stopper it tightly. As the can cools, the steam inside it condenses into water, leaving a partial vacuum within the can. As the pressure inside the can decreases, the atmospheric pressure crushes the can.

b. If the school has a vacuum pump or if one can be borrowed from the high school, it is much more desirable to crush a can by pumping the air from it with a pump rather than by the method described above. This will eliminate any confusion about the water, heat source, and the delay during cooling. By using a pump, the children will see the can collapse as the air is being removed. The pumping action can be stopped at any time and then started again to allow time for discussion of observed results.

8

Wet the edge of a plumber's rubber sink plunger, press it against a smooth surface, and let children demonstrate the force necessary to lift it. Prepare a second rubber plunger by making a hole through it. Either a hole can be drilled through the rubber, or a nail which has been heated red hot over a burner can be pushed through it. Let the children press this plunger against a smooth surface. Why doesn't it react in the same manner as the other plunger? Will it, if a finger is placed over the hole?



9

To demonstrate that the pressure in moving air is less than the pressure in still air, tie strings to two apples and suspend them from a support an inch or two apart. Ask pupils to blow between the apples and to try to blow them further apart. Instead of moving further apart the apples will bump together because the air moving reduces the pressure between them.

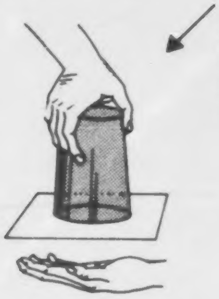
10
A bicycle pump, a basketball, and a needle valve can be used to show that air heats when compressed and cools when it expands. Attach the needle valve to the pump and insert it into a deflated basketball. As the compressed air is being forced into the ball, feel the cylinder of the pump. What has happened to its temperature? Remove the needle from the pump and insert the unattached needle back into the ball so that the air is allowed to escape. Feel the escaping expanded air. Is it cool? To demonstrate that the pump did not get hot from friction when the ball was inflated, work the plunger of the unattached pump a number of times, to show that the cylinder does not become as warm.

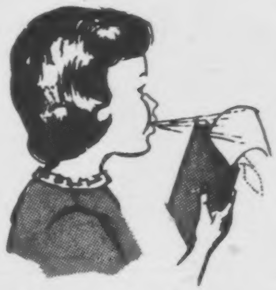
11
Use a large wall chart to illustrate the various layers of the atmosphere. If no such chart is available, a suitable diagram from a textbook can be projected for class use with an overhead projector.

12
Place a Ping-Pong ball in the air stream of a reversed flow vacuum cleaner. Why does the ball remain suspended? Why can you move the hose back and forth without losing the ball?

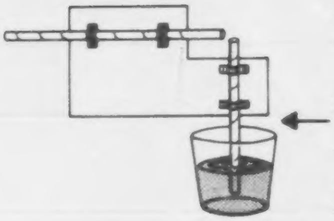
Activities for children

1
Fill a tumbler to the brim with water and place a thin sheet of cardboard over it. Holding this in position with one hand, invert the tumbler. Why does the cardboard continue to hold the water in the inverted tumbler after it is no longer held in place by the hand? Can you substitute a gallon jug for the glass? Does the volume of the container change the result? Why?



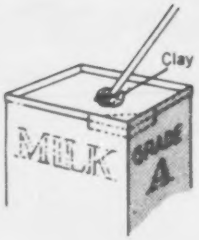


2
Place one end of a sheet of paper between the pages of a book. Blow over the top of the book. Why does the paper rise?



3
The principle of the atomizer can be demonstrated with soda straws and a tumbler of water. Attach the straws as shown in the illustration and blow in the horizontal straw. As a result, water will rise in the vertical section to form a spray. Why does the water rise in the straw?

4
Try to drink water from a glass without your upper lip touching the water surface. Does this show the effect of air pressure on liquids?



5
When we use a straw, we remove some of the air from the straw and air pressure on the surface of the liquid forces the liquid into the partial vacuum we have created. Make a small hole in the top of a milk carton only large enough to allow the straw to pass through. It may be necessary to use clay or melted wax to assure a tight seal between the straw and the carton. What happens when we try to drink from the straw?

ENRICHMENT

Questions to stimulate further thought

1. Because of the weight of the air above us, air pressure at the surface of the earth is nearly 15 pounds on each square inch. What is the total force pressing on the surface of a pupil's desk top? Why doesn't the desk collapse?
2. Could a man in a space suit floating in space attach himself to a spaceship by the use of a large suction cup?
3. Why does the troposphere extend higher over the equator than it does over the poles?
4. How could we drink liquids on the moon, or out in space?

Topics for additional exploration

1

The balloon flights of Auguste Piccard. Piccard's flights provided the first actual experiences in high atmosphere.

2

The composition of the air. What gases besides oxygen make up our atmosphere?

3

Air pollution. Not only are smoke particles and fumes polluting our atmosphere, but radioactivity may be a future problem as well.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1

Make a large mural showing a diagram of the various layers of the atmosphere. On this mural include such items as the height of orbiting satellites, where meteors are seen, highest mountain, deepest mine, cloud formations, altitude record for propeller-driven planes, altitude record for jet planes, and so on.

Questions to guide a summary of experiences

1. What is air composed of?
2. What are some of the properties of air?
3. What are some of the ways that we use atmospheric pressure in our daily lives?
4. What are the three layers of the atmosphere and how do they differ from each other?
5. Why do we put two holes in the top of a juice can?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Air is a mixture of oxygen and other gases.
2. Air takes up space and has weight.
3. Air exerts pressure.
4. A barometer measures air pressure.
5. Pressure in moving air is less than pressure in still air.
6. Air heats when it is compressed and cools when it expands.
7. The air surrounding the earth is called the atmosphere.
8. The three layers of the atmosphere are the troposphere, the stratosphere, and the ionosphere.

VOCABULARY

atmosphere
compress
expand
ionosphere
oxygen
pressure
stratosphere
troposphere

SCIENTISTS

Bernoulli, Daniel
Piccard, Auguste
Piccard, Jean

Fifth Grade

d THE EARTH AND ITS COMPOSITION

THE EARTH SURFACE AND INTERIOR

PURPOSE OF THE UNIT: ***to learn about the earth's interior and how the earth's surface developed into its present form***

Apparatus and materials

1. Boxes, wood, two (approximately 16 inches x 12 inches x 4 inches)
2. Cans, sprinkling
3. Cartons, milk
4. Hardware cloth
5. Hydrochloric acid, dilute
6. Jar, quart
7. Jar with screw-type lid
8. Marble or limestone
9. Percolator
10. Plaster of paris
11. Pumice
12. Sod or soil
13. Volcanic rock collection

INTRODUCTION OF THE UNIT

Motivating activities

1
Display pictures of active volcanoes.

2
Show a piece of pumice. If it will float, demonstrate this for the class. Can this be a rock if it floats?

3
Show photographs of Old Faithful geyser.

4
Show pictures of studies which are being conducted in order that we may understand more about the structure of our earth.

5
Study a profile of a vertical section of the earth showing topsoil, subsoil, and bedrock.

6
Visit an area where gully erosion is rapidly moving the soil.

7
Arrange a bulletin board display of pictures illustrating soil conservation practices.

8
An abundant supply of good films and filmstrips is available and may be used to introduce these topics.

9
Display a picture which diagrams the earth's interior.

Motivating questions

1. Why do we believe it is hot deep down under the earth's surface?
2. What eruptions other than volcanoes give evidence of the high temperature of the interior of the earth?
3. Can earth movements be noticed?
4. From what is soil made?
5. Why is soil so important to us?
6. What are some different types of soil?
7. If the oceans were originally filled by rain, how did they get salty?
8. How are caves formed?

EXPERIENCES RELATING TO THE UNIT

Note: Plaster models of volcanoes are sometimes constructed to hold certain chemicals in their cones. These chemicals, when ignited, sparkle and produce a greyish ash supposedly demonstrating an active volcano. This demonstration is NOT recommended. First, it is unsafe; second, it does not demonstrate how a volcano truly functions. Even though spectacular, a demonstration which does not teach desirable principles and which is also dangerous, should be avoided. A moving picture color film on volcanic eruption will have more value.

Teacher-directed activities

1
A percolator can be used to demonstrate geyser action.

2
Display pictures of limestone caverns. Discuss the origin of limestone caverns and the cave formations which are often found in them.

3
A drop of dilute hydrochloric acid (borrowed from the high school chemistry teacher) placed on marble or limestone will demonstrate decomposition of rocks. Carbonic acid in nature is weaker but given sufficient time, the results are the same. Note: *All acids should be handled with extreme caution.*

4
Show a film or filmstrip which describes the process of erosion and weathering.

5
Invite a Soil Conservation Service county agent to speak to the class about soil erosion and conservation practices. A member of a local conservation club may be utilized in the same manner.

6
Current magazine and newspaper articles are good sources of information for discussion about earthquakes and volcanoes.

7
Display a collection of volcanic rocks. (See Fourth Grade, Teacher-directed activities, No. 5.) Compare these to rocks found in the local area.

8
Demonstrate the importance of plant cover on the soil. Obtain two wooden boxes of equal size, approximately 16 inches x 12 inches x 4 inches. Line them with watertight material. At one end of each box cut a V notch, 1 inch to 1½ inches deep. Insert a spout cut from a tin can cover to serve as a drain. Cut a piece of sod from a lawn or pasture lot that will fit in one of the boxes. Fill the other box with soil from the same area. Place the boxes side by side on a table so that the spouts extend over the side. Elevate one end of the boxes. An empty jar should be placed on stools or boxes underneath each spout. Fill two sprinkling cans, at least 1 quart in size, with water. Sprinkle the water from each can on the boxes. The runoff will show the importance of plant cover in helping to prevent erosion.

9
Fill two boxes (see previous demonstration) with soil obtained from the same locality. Use your finger to "plow" across the soil in one box and up and down in the other box. Elevate one end of the boxes and place clean jars beneath each spout. Fill quart-sized sprinkling cans with an equal amount of water. Sprinkle the two boxes at the same time from the same height. Notice the difference between the flow of water from the two surfaces. Compare the contents which collect in the jars.

10
People who are interested in exploring caves may be contacted as resource persons. Usually they belong to a national organization, the National Speleological Society. They often are able to provide an illustrated program about caves and cave formations.

Activities for children

1
Obtain a mayonnaise jar with a screw top lid. Fill it one-third full with good topsoil. Add enough water to fill the jar to two-thirds level. Screw on the lid and shake the jar vigorously, then let the jar stand undisturbed while the contents settle. The soil particles will sort themselves to size and build up layers on the bottom. Its various components, sand, clay, and loam, can be recognized.

2
Make a hill of sand on a tray. Use a sprinkling can to make "rain" fall on the hill. What happens to the hill? What will finally happen to the hills on earth? Why haven't all the hills in the world been eroded away?

3
If any pupils have folders describing and illustrating limestone caverns they can be used as material for a short oral report.

4
Report to the class on the interest Theodore Roosevelt had in the conservation movement.

5
Find out about the formation of Crater Lake.

6
Read accounts of some famous volcanoes (Paricutin, Vesuvius, Mt. Pelee) and tell these stories to the class.

7
Report to the class on the explosion of Krakatoa.

8
A small group can collect pictures of the Rocky Mountains or the Alps (young mountains) and the Appalachian Mountains (older mountains). Show these pictures to the rest of the class and report on the differences between young and old mountains. Explain what is meant by young mountains — old mountains. Compare their appearance, locality, and approximate age.

9
Models to illustrate patterns of crustal movements may be made from plaster of paris or a block of wood. Mix plaster of paris; pour it into a mold made from a half-pint milk carton whose top has been cut off. A quart carton can also be used and should be cut to about the same size. When the mixture is dry the block may be removed. Using textbooks as guides, paint these with various colors to represent different rock layers. Various other models to illustrate geologic features, such as folding, faulting, and mountain-building, can be made using the same technique. Layers of colored clay pressed together make excellent models to show folding and faulting. A larger classroom demonstration model can be made by pouring the plaster of paris mixture into a wooden or metal chalk box. Follow the same procedures used with the smaller models. Layers of plywood of varying thicknesses can be glued or nailed together as a substitute for the plaster of paris. The sides of the material can be painted to represent the rock layers.

Fieldwork

1
Commercial limestone caverns may be visited in some areas of the State. Those living in areas where this is a physical impossibility may have this experience vicariously through the use of films, museums, or resource people.

2
Interesting and profitable directed field trips to observe evidence of soil conservation are dependent on the location of the school. If such a trip is undertaken, it might be a good idea to contact the local Soil Conservation agent. He may lend aid as a guide or provide advice about desirable places to visit.

3
Take a 36-inch field trip. Give each child a piece of string 36 inches long. Take the children outside the school to an area covered with grass. Each team of students will pick an area and make a circle on the ground with the string. Now each team may examine the area within the circle to see what they can find which relates to the soil. They may find bits of rock, plants and plant debris, seeds, insects, worm burrows, etc. Dig up a small area within one of the circles with a trowel. Separate some findings into piles to show what makes up soil. This may include decaying plant and animal matter, different sized rock particles, insects, worms, and other animals.

ENRICHMENT

Questions to stimulate further thought

1. How much of our topsoil is carried into the ocean by rivers each year?
2. What is the effect of forest fires on soil erosion? Why?
3. Of what importance are burrowing animals to the conservation of topsoil?
4. Why does the Great Salt Lake of Utah get more and more salty? What is happening to the size of the Great Salt Lake?
5. Will sediment carried by the Colorado River ever fill Lake Mead behind Hoover Dam?
6. Some of the most productive fruit and vegetable crops are grown in desert regions of our western states. How is this possible?
7. What causes earthquakes? What are faults?
8. Are limestone caverns useful for purposes other than interesting places to explore or as tourist attractions?
9. Where do limestone caverns occur?
10. Is it possible that volcanoes may have existed in what is now New York State? What is Stark's Knob in Schuylerville, Saratoga County?
11. Can volcanoes provide information about the earth's interior?
12. Where is erosion by running water occurring very rapidly? By wind? By ice?
13. How is composting valuable?

Topics for additional exploration

1
Volcanic islands. Volcanoes erupt under the oceans as well as on land. The Hawaiian Islands are actually the peaks of volcanoes which stick out above the surface of the ocean.

2
Erosion of topsoil. Erosion removes great quantities of topsoil from our land. Soil conservationists have estimated that the Mississippi River alone carries over 500 million tons of topsoil into the ocean in a single year.

3
Topsoil replacement. Topsoil builds up on the earth's surface at a rate of approximately 1 inch in a thousand years.

4
Conservation of topsoil. Topsoil can be conserved by crop rotation, contour plowing, and by keeping the land planted.

5
Loss of topsoil. Our topsoil is being lost more rapidly than nature is replacing it.

6
The Mohole. Operation "Mohole" is an important scientific investigation to gather information about the earth's mantle, the layer that lies beneath the crust.

7
Dams. Many large dams have been constructed in our western states as a means of storing water, flood control, and obtaining hydroelectric power.

8
Volcanic belts. Volcanoes do not occur at random over the face of the earth. There are certain areas and belts in which they are found. Locate these belts on a globe.

9
Geysers in Iceland. The study of geysers (an Icelandic word) is interesting. The spring water is used for heating buildings in Iceland.

10
Industrial uses for natural heat. The heat from the interior of the earth has been harnessed for industrial purposes in some countries. Industrial plants are run by volcanic steam in Italy, Sicily, Iceland, Chile, and Bolivia. The most successful of all is in Larderello, Tuscany.

11
Chemical disintegration of rocks. Lichens, a group of primitive plants, contribute to the chemical disintegration of rocks. As the rock surfaces gradually crumble, and the remains of these plants are added from year to year, soil is formed. The soil then provides a place for the growth of other plants.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make a model of a conservation farm.

2
Make dioramas showing good and poor conservation practices.

3
Make a large mural depicting the results of good and poor conservation practices.

4
Models of various land forms can be constructed of plaster of paris, modeling clay, or papier-maché. Mountains, volcanoes, river valleys, waterfalls, and geysers are more interesting if the model is constructed to show a cross-sectional view.

5
A diorama depicting a limestone cavern in a cross-sectional view may be constructed from a wooden box, plaster of paris, and hardware cloth (a trade name for a coarse wire screening). Replace one of the sides of the box with hardware cloth which will serve as a ceiling of a cavern. Plaster of paris poured over the screening will drip down and produce stalactites, at the same time forming stalagmites. Places where formations are not desired may be covered with cloth or cardboard to prevent the plaster from going through the screen.

Questions to guide a summary of experiences

1. What is the difference between magma and lava?
2. Is topsoil a renewable resource?
3. Since topsoil is continually being produced by nature, why must we work to reduce erosion?
4. Why are some bacteria and worms good to have in the soil?
5. Can you suggest three ways in which plants help to prevent erosion?
6. How do sinkholes and limestone caverns form?
7. What evidences do we have that the interior of the earth is hot?
8. Can you name three conservation practices which reduce soil erosion?
9. What forces contribute to the building up of the earth's surface?
10. Why is the ocean salty?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. The interior of the earth is hot.
2. Geysers and hot springs bring dissolved minerals to the earth's surface.
3. Volcanoes, earthquakes, and geysers are earth-building forces.

4. Weathering and erosion wear down the surface of the earth.
5. Water, wind, chemical reactions, temperature changes, and plant growth slowly disintegrate rock.
6. Disintegrated rock is moved to lower areas by water, ice, and wind.
7. Topsoil is often lost faster than it is replaced.
8. Topsoil contains sand, silt, clay, and humus.
9. Soil conservation practices include crop rotation, terracing, and contour farming.
10. The ocean has been made salty by the dissolved minerals that streams have carried into it.
11. Limestone caves are formed by action of water as it seeps down through rocks.
12. The depletion of resources, including soil, changes the way we live.

VOCABULARY

cavern
compost
conservation
contour
crop rotation
disintegrated
dissolved
erosion
geyser
interior
lava
limestone
magma
silt
sinkhole
subsoil
terracing
topsoil
weathering

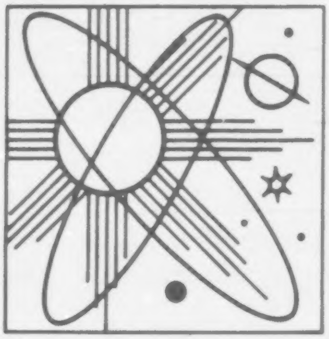
SCIENTISTS

Agassiz, Louis

Fifth Grade

e THE SOLAR SYSTEM AND BEYOND

RELATIONSHIP OF THE SOLAR SYSTEM TO THE UNIVERSE



PURPOSE OF THE UNIT: *to learn about the relationship of the solar system to the universe beyond it*

Apparatus and materials

1. Aluminum foil
2. Ball, styrofoam or rubber
3. Balls, Ping-Pong
4. Boards, or heavy cardboard
5. Camera with tripod
6. Cardboard containers (round)
7. Clay
8. Flashlight
9. Hot plate
10. Household cement
11. Ink, white
12. Nails
13. Planetarium
14. Projector, filmstrip
15. Slides, blank, 2 inches x 2 inches
16. String
17. Solar system chart
18. Tape, masking
19. Telescope
20. Thread

INTRODUCTION TO THE UNIT

Motivating activities

1
Ask the children the question "Where are you?" They may have a limited concept of where they are, such as city, village, or country. Develop the following concept:

"Where are you?"
Seat
Room
School
Section of town (ward, borough)
Town or city
County
State
Country (United States)
Planet (earth)
Sun's solar system
Milky Way Galaxy
Universe

2
Make some large flash-card pictures mounted on construction paper or oak tag for the purpose of review of previous work. Pictures may include the solar system, the moon, the earth, a diagram of the seasons, and phases of the moon.

3
Display a large chart of the solar system which includes asteroids, meteors, and comets, in addition to planetary information.

4
Display pictures of the sun which show solar prominences and sun spots.

Motivating questions

1. What is the center of our solar system?
2. What are the names of the planets in our solar system?
3. Why do stars seem to move across the sky?
4. What is the Milky Way?
5. What are some of the theories which attempt to explain the foundation of our solar system?
6. Are the stars further from us than Pluto?
7. Based upon current knowledge, how is the planet earth different from other planets?
8. What keeps the planets in their orbits?
9. Are stars other than the sun visible in the daytime sky? Why?
10. Do planets other than the earth have moons?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
If your school has a small planetarium available, use it in a darkened classroom. Perhaps a large sheet may be arranged as a projection surface on which part of the constellations may be projected at one time. Point out familiar constellations.

2
Discuss some of the theories regarding the origin of the universe through the use of films and filmstrips.

3
Obtain star maps from various magazines or other sources. Discuss their use, locations of various constellations, and those that are observed in particular seasons.

4
Meteor showers (discourage the term "shooting stars") may be observed by watching for announcements of these astronomical displays in magazines and newspapers.

5
Children will see that the patterns of many constellations lend themselves to various shapes. With a little imagination, lines may be drawn between the stars to suggest a particular shape. The imagined shape names the constellation.

Note: Firsthand observations are necessary if children are to have clear astronomical concepts. These experiences also afford the children the opportunity to correctly orient themselves with regard to direction, as well as the location of various astronomical bodies.

6
The twinkling of stars is caused by the motion of our atmosphere, not by the star. To demonstrate how air can cause distant objects to shimmer, place a hot plate on the window sill and allow it to get red hot. Have the children look out the window, sighting just over the top of the hot plate. The objects viewed will appear to shimmer much the same as stars appear to twinkle. Children have probably noticed this phenomenon close to the road surface while riding along a highway during a hot summer day.

Note: We sometimes refer incorrectly to this shimmering effect as " heat waves." What we actually see is light which has been unevenly refracted as it travels through different densities of air. The varying density of air is the result of unequal heating.

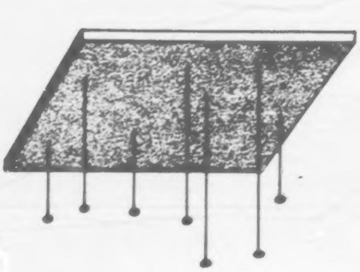
Activities for children

1
Make a table or chart summarizing the information which has been collected about the solar system. Different column headings may be used for planet, distance from the sun, diameter, length of day, length of year, color, order in size, order in distance from the sun, and the possibility of life.

2
Use information from textbooks and reference books to make a chart illustrating sunspots; their size, location, and movement.

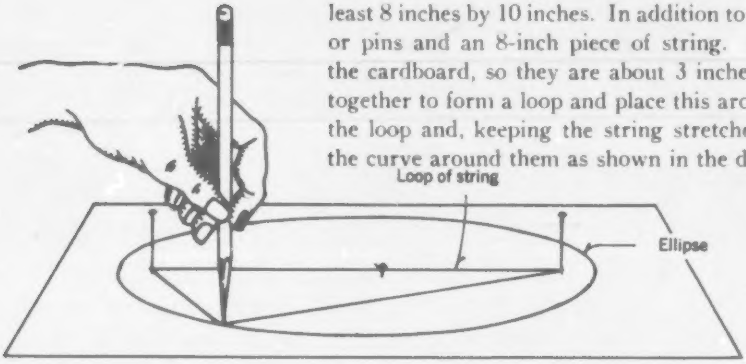
3
Draw pictures of some of the prominent constellations which are visible during the different seasons. Label them as to name, season when they are prominent, and symbols for prominent stars.

4
Obtain a large piece of construction paper, about 3 feet by 2 feet. Outline in pencil the stars which make up constellations visible in the northern hemisphere. Make holes through the stars, the holes being slightly larger for the brighter stars. Using a lettering pen, connect the stars with white ink to outline the constellations. When dry, the paper can be fastened to the window with masking tape so that light will appear through the tiny holes. The stars alone may not suggest any particular pattern to the children, or the children may see designs other than those normally attributed to the constellations. However, the connecting lines which have been drawn in on the paper will help them follow the designs imagined by men thousands of years ago.



5
Suspend Ping-Pong balls from a board, using fine thread and household cement as shown in the diagram. When viewed from one side, the balls (stars) form a dipper, but when viewed from other directions, the figure formed is different. Star groups are not all in one plane and their apparent positions depend upon the observer's position.

6
The orbits which the planets follow around the sun are ellipses. An ellipse is a particular kind of curve which can be constructed by the pupils. Supply each child, or each small group of children, with a piece of heavy cardboard or a wooden board large enough to hold a piece of paper whose dimensions are at least 8 inches by 10 inches. In addition to the paper, they will need two thumbtacks or pins and an 8-inch piece of string. Press the tacks through the paper into the cardboard, so they are about 3 inches apart. Tie the two ends of the string together to form a loop and place this around the two tacks. Hold a pencil inside the loop and, keeping the string stretched with the point of the pencil, describe the curve around them as shown in the diagram.



Repeat after moving the tacks closer together or further apart. Note that as the pins are moved closer together, the figure becomes more nearly circular.

7
Develop the understanding that the apparent daily motion of the stars is the result of the earth's rotation. Have the children draw the prominent stars and star groups of the southern sky on the blackboard. Now ask each pupil to stand with his back to the blackboard, holding hands up to the eyes to act as blinders, and to rotate his body slowly in a counterclockwise direction just as the earth rotates. The stars on the blackboard will appear to rise, move across the black sky, and set just as they really do. The effect will be much more realistic if pupils make several rotations.

Fieldwork

1
Take the children outdoors on a warm clear evening for some firsthand observations and a review of some of their knowledge of astronomy.

2
Arrange for some stargazing sessions to locate prominent constellations such as the northern circumpolar constellations. Locate the Big Dipper, Little Dipper, Cassiopeia, Cephus, Draco, and Andromeda. Note the separate stars in the handle of the Big Dipper, Mizar, and Alcor. Through a telescope, Mizar is observed as two stars very close together or as a "double star." The changing seasons bring different prominent constellations and stars into view. Star maps will provide information about what constellations are visible and when.

ENRICHMENT

Questions to stimulate further thought

1. Where is the planet Pluto? How was it discovered?
2. Why do astronomers believe that the sun, not the earth, is the center of the solar system?
3. Although astronomy is a very old science, there is still much more to learn. What are some of the questions that we have not yet answered?
4. How long would it take to travel to the nearest star if a rocket could travel at a million miles per hour?
5. What is a Foucault Pendulum? What does it demonstrate? Why?
6. How might the planetoids have formed?

Topics for additional exploration

1

Apparent motion of the stars. The stars only appear to move across the sky. Actually it is the earth that is moving, revolving about the sun, and rotating on its axis. On a clear night, when the stars look bright, set up a camera on a tripod and point it toward the North Star (Polaris). Set the camera for a timed exposure ("T" on the shutter speed). Press the shutter release and leave the camera undisturbed for half an hour. Return to the camera and press the shutter release button to trip the shutter closed. Some cameras have a "B" setting. On these models, the shutter button will stay open only as long as you hold the shutter button. If this type is used, the button will have to be taped down or held with a rubber band. Take care not to move the camera while doing this. The developed print will show Polaris surrounded by concentric star trails.

The picture shows that either the earth is rotating on an axis directed toward Polaris or the stars are all revolving around one point in the sky. This picture illustrating the star trails does not by itself prove that the earth is rotating, but, with other evidence, it will contribute to the child's understanding.

2

Planetary motion. In addition to the revolution and rotation of the planets in the solar system, the entire solar system is moving through space at a rapid pace.

3

Comets. Comets are members of the solar system that may be observed periodically as they move in their orbit around the sun. As the comet nears the sun, the tail of the comet becomes brighter and is more easily observed. The tail may be millions of miles long and always points *away from* the sun.

4

Planetoids. Planetoids are small bodies revolving around the sun, generally located between the orbits of Mars and Jupiter. They are sometimes referred to as asteroids.

5

Orbits of the planets. Diagrams illustrating the orbits of the planets can be constructed to a single scale. Refer to "Activities for children," No. 6, for general information about drawing ellipses. The data for drawing the orbits for the planets are listed below. The ellipses may be drawn on a large sheet of wrapping paper.

PLANETS	Approximate Distance From Sun at Closest Distance in Millions of Miles	Approximate Distance From Sun at Furthest Distance in Millions of Miles
PLUTO	2,800	4,500
NEPTUNE	2,800	2,800
URANUS	1,700	1,900
SATURN	840	940
JUPITER	460	500
MARS	130	160
EARTH	91	94
VENUS	67	68
MERCURY	29	43

6

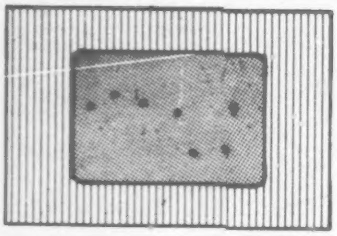
Sunspots. If the school has a telescope which is equipped with a projection screen, take the children outside to observe sunspots on the *projected image.*

Note: NEVER *look at the sun through a telescope or binoculars, not even when lining up the telescope. Be sure the children do not have an opportunity to peek through the telescope eyepiece when studying the sun.*

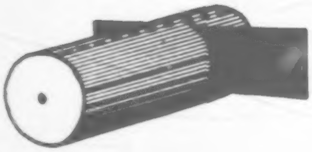
ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make models of Jupiter or Saturn. The planet itself is the center of a satellite system with its satellites moving in their orbits about it. The planet may be represented by a styrofoam or rubber ball painted to resemble the planet. It can be supported by a wire rod or nail on a base of soft wood. Miniature satellites can be made of aluminum foil or clay mounted on pins projecting from the planet at various distances and intervals. An alternate plan would be to stick the pins which hold the satellites into the soft wood base on which orbits have been drawn.



2
A collection of constellations may be made from blank 2-inch by 2-inch slides to be used in the slide projector. Obtain some opaque 35mm film slides which were not exposed before developing. Using a common pin, make pinholes in the opaque film to represent the shape of a constellation. Even better results can be obtained by removing the film from a 2-inch by 2-inch slide, replacing it with a sheet of aluminum foil. Make pinholes in the foil to represent constellations. Try this with an easy one first, such as the Big Dipper. These may be placed in a slide projector and projected on a wall or screen as a means of familiarizing the children with the constellations. They may also be used as a recognition quiz or summary of a stargazing trip. With some practice, the children may become adept enough to adjust the size of the holes in relation to the brightness of the stars.



3
Children may construct their own planetarium from a cylindrical cardboard container, of the type used to package some cereals. About 1 inch to 1½ inches from the open end of the container, cut a slit on each side large enough to admit a piece of construction paper. Cut pieces from black paper whose dimensions should allow for some overlap on either side and also pass through the container. (Approximately 3 inches by 5 inches should suffice.) Make holes in the pieces of construction paper with a pencil point to represent the stars in a constellation. Cut a hole about the size of a dime in the center of the covered end of the container. Insert the constellation card and hold the card toward a light. You will see the constellation as it appears in the night sky. Make some cards for other constellations and label them.

4
Using the device described above, you may project your constellations with only slight adaptations to the container constructed previously. Enlarge the hole in the covered end of the container large enough to hold a flashlight. Insert a flashlight. When the light is turned on in a darkened room, the constellation can be projected on the wall or ceiling.

5
Write a play about the life of Galileo or Copernicus. Such an activity should require some reference work on the part of the children. Some children may be responsible for writing the play, while others may do the acting, construct backdrops, or serve as stage managers. The play can be presented to another class or the whole school.

6
Report on some ancient myths which relate to beliefs of how the earth is supported.

7
Report on the origins of the names of planets and constellations.

8
Keep a scrapbook for the class of newspaper reports on astronomical observations, such as comets, meteor showers, telescopes, and new discoveries.

Questions to guide a summary of experiences

1. What are some theories about the origin of the solar system?
2. What are sunspots?
3. What is the sun and what is it made of?
4. What are galaxies?
5. Name three different movements of the planets.
6. What are constellations? How are they named?
7. Why do the stars appear to move?
8. Can you describe the solar system?
9. Why can different constellations be observed during different seasons?
10. Can you name and describe some common constellations?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. The solar system is composed of the sun, planets, satellites, planetoids, meteors, and comets.
2. There are various theories describing the origin of our solar system and the universe.
3. The sun is a sphere of hot gases.
4. Disturbances (storms) on the sun's surface are called sunspots.
5. The volume of the sun is about 1 million times the volume of the earth.
6. The planets rotate as they revolve.
7. Our sun is an average-size star.
8. Galaxies are huge collections of stars. Our galaxy is called the Milky Way.
9. The stars in our sky seem to revolve around the earth because of the earth's rotation.
10. Constellations are groups of stars which appear to outline a figure.
11. Different constellations come into view with the change in seasons.

VOCABULARY

comet
constellation
galaxy
meteor
meteorite
Milky Way
observatory
origin
planetoid (asteroid)
telescope
theory

SCIENTISTS

Brahe, Tycho
Copernicus, Nicolaus
Galilei, Galileo
Halley, Edmund
Kepler, Johannes
Newton, Sir Isaac
Ptolemy, Claudius

Fifth Grade

f MATTER AND ENERGY

ELECTRICITY

PURPOSE OF THE UNIT: ***to help the pupils understand and appreciate the role of electricity in their lives***

Apparatus and materials

1. Balloon
2. Bells or buzzers
3. Cloth, silk
4. Cloth, wool
5. Dry cells
6. Galvanometer
7. Generator, hand operated (magnetoelectric generator)
8. Nails, 4" common
9. Puffed rice or puffed wheat
10. Rod or comb, hard rubber
11. Screwdriver, small
12. Socket, flashlight, with bulbs
13. Switches, knife
14. Switches, push button
15. Thread
16. Transformer, train
17. Wire, insulated (bell wire)

INTRODUCTION OF THE UNIT

Motivating activities

1

Turn the crank of a hand generator which is connected to a bulb. Have pupils notice the relationship between the turning and the illumination of the bulb. Ask the class: What makes the bulb light? Where does the electricity come from? Where does it go when the crank stops turning? Can we make the bulb brighter — dimmer?

Motivating questions

1. Can you see electricity?
2. Does electricity move?
3. From where does electricity come?
4. How do we use electricity?
5. What is a fuse?

EXPERIENCES RELATING TO THE UNIT

Note: In order to have the desired results with activities concerning static electricity, it is necessary to wait for cool, dry days. On humid days, the air acts as a conductor; any charged object loses its charge into the surrounding atmosphere, so that no effects can be noticed.

Teacher-directed activities

1

Rub an inflated balloon on a woolen skirt or jacket. Place the balloon on the wall or ceiling.

2

Touch a small bit of paper with an uncharged hard rubber rod (or comb). Rub the rod vigorously with a piece of wool and bring it near the piece of paper again. Discuss difference in behavior.

3

Rub a hard rubber rod with wool or a piece of fur and dip the charged rod into a box of puffed rice. Remove rod from box and observe action. Have class try to explain why rice particles jump off the rod after having been originally attracted to it.

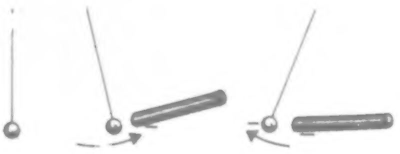
4

To explain the observed behavior of charged objects, the children will have to be aware of the nature of electrical charges.

Matter is composed of atoms, and the atoms, in turn, are composed of positive and negative charges. An object is said to be neutral or uncharged when it has an equal number of positive and negative charges. Negative charges can be moved fairly easily but positive charges do not move (under normal conditions). When two objects are rubbed together, negative charges, which are actually electrons, rub off of one object and onto the other. The object which has picked up or gained extra electrons is said to be negatively charged. The object which lost electrons is said to be positively charged. Be sure to point out that positive charges result from the loss of electrons, *not* from the collection of positive charges.

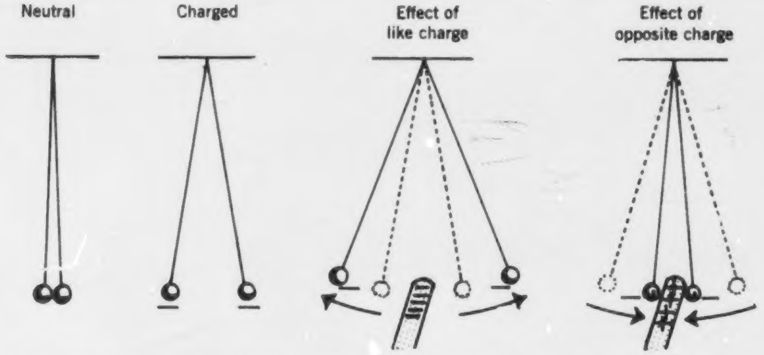
5

To demonstrate the effects of like and unlike charges, suspend a piece of puffed wheat or rice from a foot of thread, as shown in the diagram. A negatively charged rubber rod will attract the suspended body, which demonstrates that objects which have differing charges attract each other. If the piece of cereal touches the rod, part of the negative charge moves from the rod onto the cereal so that they both are negatively charged. Then the charged piece of cereal is repelled from the rod, since like charges repel each other. The teacher should practice this prior to presentation to the class. See note above Activity 1.



6

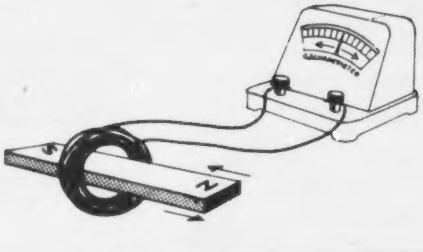
Two grains of puffed wheat suspended from thread (as illustrated) will demonstrate the attractive and repulsive forces of unlike and like charges: To charge the pieces of cereal, touch them with a rubber rod which has been briskly rubbed with fur or woolen cloth.



A positive charge can be placed on a glass rod by rubbing the rod with a piece of silk.

7

If the air is very dry, rub a hard rubber rod briskly with wool or fur, and then bring end of charged rod near the tip of a pupil's nose. A small, harmless spark will jump from the rod to the pupil as the rod gives off the excess electrons it has acquired. This tiny spark is similar to lightning. During a thunderstorm, great currents of air move rapidly through large distances. Electrons get displaced during the process until great charges are built up. We see the resulting spark of discharge which we call lightning. Discuss the safety precautions which people should observe during an electrical storm. Explain that it is air heated by electricity which is visible, not electricity itself.



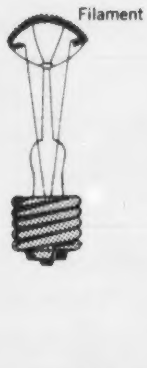
8

Make a coil by wrapping about a dozen turns of insulated wire around three fingers. Connect the ends of the wire to a galvanometer. Push a bar magnet in and out of the coil. Observe that the current generated makes the galvanometer register.

Notice that electrical current is only produced when the magnet or the coil is moving. Repeat with more or fewer turns of wire on the coil. Try moving magnet very slowly, and then rapidly.

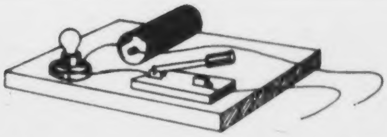
9

Remove some strands of wire from a piece of window screening or separate the individual strands in picture-hanging wire. Connect one of these strands across the terminals of a train transformer and slowly turn up the voltage. The heating effect of electricity passing through the wire can be shown by holding a piece of paper against the wire; the paper will char. By increasing the voltage from the transformer, or by using a shorter length of wire, the heat will become great enough to make the wire glow and produce light. Discuss the operation of a toaster, an iron, and the light bulb.



10

Place a light bulb in a lamp and turn the lamp on. Have pupils speculate on its internal construction. Remove the bulb from the socket and wrap it in heavy cloth. Tap the wrapped bulb with a hammer to break the glass envelope. Remove the cloth carefully and show pupils the construction of the bulb. The larger type bulb often found in a gymnasium is excellent for this demonstration.



Insulation removed from ends of wire. Hold ends against material to be tested.

11
Use a homemade conductometer to illustrate conducting and insulating materials. To a board, fasten a knife switch and a socket that fits a flashlight bulb. Connect as shown in the diagram. The dry cells can be taped to the board so that the apparatus is easier to move.

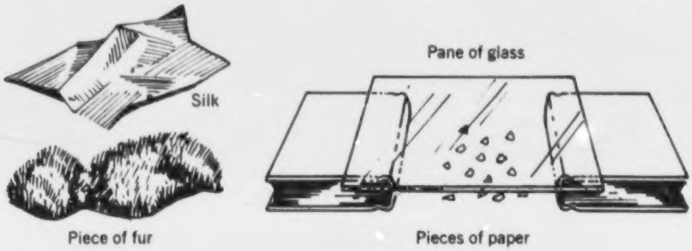
To be sure that the conductor is properly connected, touch the two wire leads together and the bulb should light when the switch is closed. To test whether or not various objects or substances are conductors, touch two leads into cups or jars of liquid. Try salt water, vinegar, sugar water, and liquid soap.

12
Demonstrate the action of a hand-operated generator. Have pupils observe that the crank turns wires past the poles of magnets. The electricity we use in our schools, homes, and industries is generated in this manner. Steam (from oil or coal) or water power is used to turn huge turbines which spin loops of wire through magnetic fields, thus generating electricity.

Activities for children

1
Supply each child with a hard rubber rod or comb and a piece of wool. Using pieces of puffed rice, observe the action of charged and uncharged bodies.

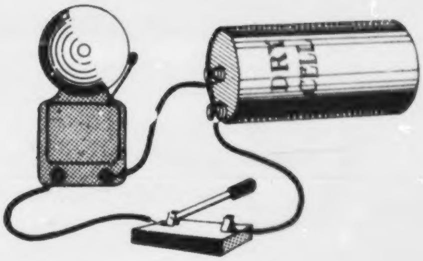
2
Lay two books on a desk, several inches apart, and place a pane of glass over them.



Place small bits of paper (confetti) under the glass. Rub the glass briskly with a piece of silk or fur, and observe the behavior of the paper.

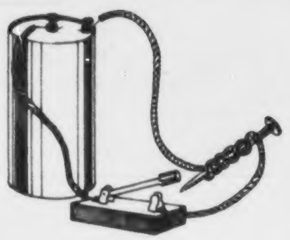
3
Have pupils relate experiences they have had with static electricity.

4
Supply each small group of pupils with 3 pieces of insulated wire (about 12 inches long), a small screwdriver, a door bell, a knife switch, and a dry cell. Ask them to connect these objects so that the switch will operate the bell.



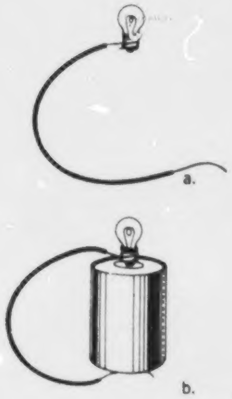
Note: Before giving the children the wire, the insulation should be removed from the ends so that about 1 inch of bare wire is exposed at each end.

After all groups have succeeded in operating the bell, discuss the function of the switch. Develop the idea that electricity *flows* through the wires and if the switch is open, it is similar to a drawbridge, so that the path is interrupted and flow is stopped. By closing the path for the electricity, the current can again flow. Have pupils disconnect the knife switch and in its place put a push-button switch. Is the effect the same? Can they imagine what the internal construction of the push-button switch is like?



5
In addition to providing heat and light with electricity, magnetism can also be produced. Provide each pupil or group of pupils with a 2-foot length of insulated wire, a 4-inch common nail, a dry cell, and a knife switch. Construct electromagnets as illustrated.

Test strength of electromagnets by lifting paper clips. Does the number of turns of wire around the nail affect the strength of the magnet? When not using the electromagnets, keep knife switch open so as not to decrease the life of the dry cell.



6
Wrap one end of a short piece of bell wire around the screw-like base of a flashlight bulb, so that it holds the bulb tightly. Bend the remainder of the wire in the shape of the letter "C". Set the tip of the flashlight bulb on the center terminal of a flashlight cell and adjust the free end of the wire so it is against the bottom of the cell. If the connections are tight, the bulb will light. Any flashlight bulb should operate when connected in this way but the kind made for a single-cell flashlight will give a much brighter light.

Look closely at the bulb and notice the fine metal wire held in position by two heavier wires inside. A hand lens will make this easier to see. The fine metal wire is made of tungsten. Passage of the electric current through the wire causes it to become very hot and give off light.

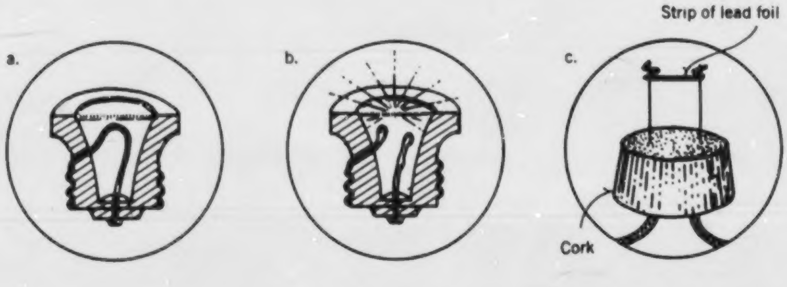
Turn the cell upside down and reverse the terminals. Note that the lamp still operates, though the electricity is flowing through the bulb in the opposite direction.

Make a diagram showing the path of the current through the bulb and around to the other end of the cell. Develop the meaning of the term "electric circuit."

7
Examine the markings on electric light bulbs and note their rating in volts (usually 115–120 volts). Find the voltage rating on a single dry cell or flashlight cell (usually 1½ volts). How many times greater is the voltage of our house current than the voltage of a flashlight cell?

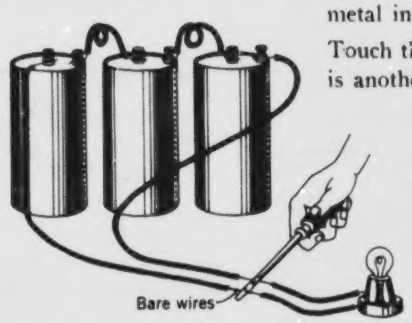
8
Examine normal and burned-out fuses. Fuses are safety devices that break an electric circuit when the circuit is overloaded. The fuse wire melts when an unsafe amount of current is flowing through a circuit.

Cut a very thin strip of metal foil from a candy bar wrapper and fasten it between the ends of two wires projecting through a cork. This will represent a model of a fuse that should work with dry cells. Experiment with different types and widths of foil until the working model melts when a dry cell is connected directly across it.



9
Connect two or three dry cells in a circuit (as illustrated) with a flashlight lamp Remove the insulation from a portion of both wires and lay a metallic object across them. The lamp goes out because the current is carried through the metal instead of through the lamp. This is an example of a short circuit.

Touch the two wires together for an instant and the lamp goes out again. This is another way that a short circuit can occur.



Next place the model fuse shown in activity No. 8 in the circuit as illustrated. Then short circuit the lamp. If the fuse does not melt, cut a thinner strip of foil. Experiment with different kinds and widths of foil until the fuse carries the current when connected properly but melts when there is a short in the circuit.

Fieldwork

1
Arrange a trip to the power plant where electricity is generated for use in the community.

2
Produce a large mural showing the story of electricity. Depending on the locality, coal, gas, oil, or water power is used to produce electricity which is transmitted into our homes for our use.

3
Take the class to a pole transformer near the school. Trace the wires back to the school to see where they enter the building. Have the school custodian show the class the main switchboard and have him describe how electrical energy is distributed throughout the building.

ENRICHMENT

Questions to stimulate further thought

1. Is it true that "lightning never strikes the same spot twice?"
2. How can the noise of thunder tell us how far away the lightning is?
3. What is electricity?
4. How does a circuit breaker operate?
5. How does a dry cell produce electricity?
6. Give pupil a bell, a dry cell, at least 5 pieces of wire, a screwdriver, and two switches. Ask, "Can you connect the bell so that either switch can ring the bell?"
7. Have a child experiment with an electromagnet, using 15 turns of insulated wire around a nail. Connect dry cells first in a series, and then in parallel circuits. How is the magnet's strength charged? Increase and decrease the number of turns and observe results. The varying strength of the electromagnet can be measured by the number of paper clips or carpet tacks it can pick up. Each variation should be tried several times so that an average may be determined.

Topics for additional exploration

1

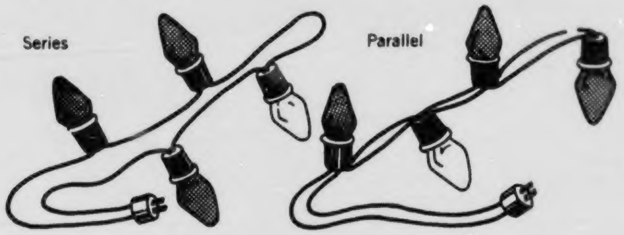
The generation of lightning. The production of lightning is not fully understood. It is generally believed that the drops of water in a cumulus cloud are constantly torn apart by air friction which produces electric charges in the water droplets. When the total charge becomes great enough, it is discharged to the earth or another cloud.

2

Benjamin Franklin's experiment with lightning. Before this dangerous experiment was performed, it was not understood that lightning and electricity were the same.

3

Series and parallel circuits. When series wiring is used for two or more light bulbs, the filament of each bulb is part of the electric circuit. If one of the bulbs " burns out ", the others will not light because the circuit is interrupted. Parallel wiring makes a complete circuit without using every individual filament so the operation of one bulb does not affect the others.



4

The electroscope. This is a sensitive instrument which can detect small electrical charges.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1

Set up a display of electrical conductors and insulators.

2

Make a list of unsafe practices in the use of electricity, such as using badly worn lamp cords, placing lamp cords under rugs, and overloading outlets.

3

Compare our present environment to an environment without electricity.

4

Using a hacksaw, cut a dry cell lengthwise. Examine the cross section of the cell. Label the essential parts of the cell and identify the materials used.

Questions to guide a summary of experiences

1. How is static electricity produced?
2. How does man produce electricity for his use?
3. How is electricity transmitted from one place to another?
4. What is a switch?
5. How does a switch operate? What does it do?
6. What is an electrical conductor?
7. What materials are good electrical conductors?
8. What is an electrical insulator?
9. What materials are good electrical insulators?
10. How do we make use of electrical insulators?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Static electricity can be produced by friction.
2. Electricity can be generated by moving wires through a magnetic field of force.
3. Electricity from the generating plant comes into our homes through wires.
4. We change electrical energy into heat, light, magnetism, and sound for our use.
5. A switch is used to start and stop the flow of electricity in a circuit.
6. Some materials are electrical conductors and some are electrical insulators.
7. Fuses and circuit breakers protect our homes from electrical accidents.

VOCABULARY

attract
circuit
conductor
dry cell
electron
filament
friction
fuse
generator
insulator
lightning
negative
positive
power
repel
resistance
switch
tungsten
volt

SCIENTISTS

Bell, Alexander G.
Edison, Thomas
Faraday, Michael
Franklin, Benjamin
Volta, Alexandro

Sixth Grade

a LIVING THINGS

b OUR GROWING BODIES

c AIR, WATER, AND WEATHER

d THE EARTH AND ITS COMPOSITION

e THE SOLAR SYSTEM AND BEYOND

f MATTER AND ENERGY

Sixth Grade

a LIVING THINGS

CLASSIFICATION OF LIVING THINGS

PURPOSE OF THE UNIT: ***to learn how living things are classified***

Apparatus and materials

1. Ant colony
2. Bird boxes
3. Cellophane or plastic wrap
4. Hand lens
5. Insect collection box and pins
6. Jars, gallon
7. Microprojector
8. Microscope
9. Mounted bird specimens
10. Rubbing alcohol
11. Screw-top vials
12. Seed-forming and nonseed-forming plants
13. Variety of animals

INTRODUCTION OF THE UNIT

Motivating activities

1
Arrange a group of objects or pieces of colored paper on a table which represent a variety of colors, shapes, and sizes. Place a printed card with the display which reads, "Can you group these objects?"

2
Prepare an exhibit of pictures of many animals, such as fish, amphibians, reptiles, birds, and mammals. Without any specific instruction, ask the class members to separate these animals into groups they feel belong together. The children will probably choose the same groupings as biologists use: fish, birds, etc. When groups have been formed, ask the children to explain why each group of animals belongs together.

3
This activity can be used to have children understand that the names of living things are time-saving symbols that replace long descriptions. Write on the board a few simple statements that contain the names of familiar living things. For example: (1) Did you see that *frog* jump? (2) I won a big brown *dog*. (3) There are no *dinosaurs* living today. (4) *Hens* lay eggs. (5) The *pig* is eating corn. Underline the names, as in the examples given. The teacher asks children to restate these simple sentences, as: "The pig is eating corn," might be: "The four-legged animal with short hair, a twisted tail, small eyes is eating corn."

4
If some symbols are to be useful, they must have the same meaning for various people in various places. Several students in the room will probably have the same first names. Call the name of such students (Bob, Jim, Susan) and ask him or her to come to the desk. All of the students with the same name should respond. The teacher may point out that if she wanted a particular person, she should have called a specific name that would identify that person from the others. There are common names and nicknames which may be perfectly acceptable under certain circumstances. Legal names are used on school and medical records, birth certificates, and application forms. When the identity of the person is important, and when confusion would be serious, the more precise legal name is better.

5
Show the children a picture of a skunk and ask them to think of the many common names they have heard that refer to this animal. Point out that there is only one scientific name for this animal, even though it has several common names. Someone may like to look up the scientific name.

6
Show the class an unlabeled picture of an unusual or exotic animal which may not be familiar to them. Ask them to suggest an appropriate name. Names may be suggested according to characteristics which are most evident to various students. Point out that great confusion would exist if all of the suggested names were adopted.

7
Exhibit a chart which illustrates the development of the horse over a long period of time (thousands or millions of years). Discuss this development.

8
Prepare a "What Is It?" display or nature quiz board with pictures, skulls, reptile skin, bird's feather, scale from a turtle shell, or a preserved specimen.

Motivating questions

1. How can you tell the difference between a lizard and a salamander?
2. What is the difference between broad-leaved trees and cone bearing trees?
3. How are turtles and alligators alike? Not alike?
4. Are rabbits rodents?
5. Did the horse always appear as it does at present?
6. What is the difference between cold-blooded and warm-blooded animals?
7. What is the difference between a moth and a butterfly?
8. Do all animals have backbones? Name some that do not.
9. Do all animals breathe by lungs? Name some that do not.

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1

As an introduction to the classification of living things, help the children classify them according to their environment. For example, animals and plants which inhabit the desert will be different from those that live in a shore or forest habitat. Call attention to the adaptations of these living things to their natural habitat.

2

Children may attempt to classify animals by their means of locomotion such as animals that swim, fly, or move on four legs. How are these animals alike? How are they different? Would this be a good way to group animals for study?

3

Before children become familiar with the process of scientific classification, they must first have an understanding of the meaning of the terms "characteristics" and "traits," and how they apply to the identification of organisms.

a. *Identifying paper figures.* Divide the class into small groups (five or six pupils per group, depending on class size). Provide each group with a set of 16 numbered figures as described in the list below. The set consists of circles, diamonds, and rectangles of two sizes and two colors. The rectangles also have two kinds of edges, straight and pinked. Have each group list the numbers 1 through 16 in order on a sheet of paper. After each number there should be written a description of the figure bearing that number. The children will formulate the descriptions through measurement and discussion. However, make sure that all groups agree on their descriptions. After this has been completed, individual pupils from the various groups can read the description of a figure without revealing the number of the figure being described. Pupils from other groups should attempt to identify by number the figure being described. For example, a figure described as a yellow diamond-edges 1½ inches long would be identified by number four.

A set of paper figures includes:

1. 1 red diamond — edges 3 inches long
2. 1 red diamond — edges 1½ inches long
3 1 yellow diamond — edges 3 inches long
4 1 yellow diamond — edges 1½ inches long
5. 1 red circle — 3 inches in diameter
6. 1 red circle — 1½ inches in diameter
7. 1 yellow circle — 3 inches in diameter
8. 1 yellow circle — 1½ inches in diameter
9. 1 red rectangle — 2 inches x 4 inches — edges pinked
10. 1 red rectangle — 1 inch x 2 inches — edges pinked
11. 1 yellow rectangle — 2 inches x 4 inches — edges pinked
12. 1 yellow rectangle — 1 inch x 2 inches — edges pinked
13. 1 red rectangle — 2 inches x 4 inches — edges pinked
14. 1 red rectangle — 2 inches x 4 inches — edges straight
15. 1 yellow rectangle — 2 inches x 4 inches — edges straight
16. 1 yellow rectangle — 1 inch x 2 inches — edges straight

b. *Identifying characteristics of living things.* Just as the characteristics of color, shape, size, and kind of edge were used in identifying the paper figures, so are these characteristics used in identifying living things. Additional characteristics are also used in identifying living things, such as body temperature, method of breathing, and outer covering. Distribute to each group a picture of *one* of the organisms from the several possible pairs listed below. These pairs were selected because they show some resemblances. Other selected pairs can be used equally as well. Each picture or specimen should be numbered. Instruct each group to describe its specimen so other pupils can recognize it. Collect the descriptions.

On the following day distribute the descriptions, without the identifying numbers, to the pupils. Make sure that no person receives the description he wrote. Place the numbered pictures, or specimen, on tables. Have each pupil match a description to a picture.

This gives practice applying descriptions to living things. If some descriptions fit both members of a pair, an excellent illustration is provided for the need of complete and accurate descriptions.

Living things.

Salamander and lizard
Frog and toad
Butterfly and moth
Cricket and cockroach
Housefly and honey bee
Maple leaf and sycamore leaf
Rabbit and woodchuck
Gray squirrel and chipmunk
Ivy and philodendron
Dog and cat

4

The principle of classification by which plants or animals having similar characteristics are grouped together can be illustrated with this activity. These groups are divided into smaller groups having more characteristics in common. The small groups are still further subdivided until the list of characteristics considered fits only a single kind of organism. Use the paper figures described in activity 3a. All of the figures taken together constitute a single group, having in common the characteristic of being made of paper. Separate the figures into two groups, each group having a common characteristic. One will have the characteristic of red and the other, yellow. Have the groups further divided into smaller ones having similar characteristics. Again, divide the groups until each has but a single figure. The fact that several bases of classification are possible illustrate that the minute categories of classification are somewhat arbitrary.

One example of a completed classification might be:

- Paper figures (Class)
  - Red in color (Order)
    - Diamond shapes (Family)
      - Smooth edge (Genus)
        - Large (Species)
        - Small (Species)
    - Circles (Family)
      - Smooth edge (Genus)
        - Large (Species)
        - Small (Species)
      - Wavy edge (Genus)
        - Large (Species)
        - Small (Species)
    - Rectangles (Family)
      - Smooth edge (Genus)
        - Large (Species)
        - Small (Species)
      - Wavy edge (Genus)
        - Large (Species)
        - Small (Species)
  - Yellow in color (Order)
    - Diamond shapes (Family)
      - Smooth edge (Genus)
        - Large (Species)
        - Small (Species)
      - Wavy edge (Genus)
        - Large (Species)
        - Small (Species)
    - Circles (Family)
      - Smooth edge (Genus)
        - Large (Species)
        - Small (Species)
      - Wavy edge (Genus)
        - Large (Species)
        - Small (Species)
    - Rectangles (Family)
      - Smooth edge (Genus)
        - Large (Species)
        - Small (Species)
      - Wavy edge (Genus)
        - Large (Species)
        - Small (Species)

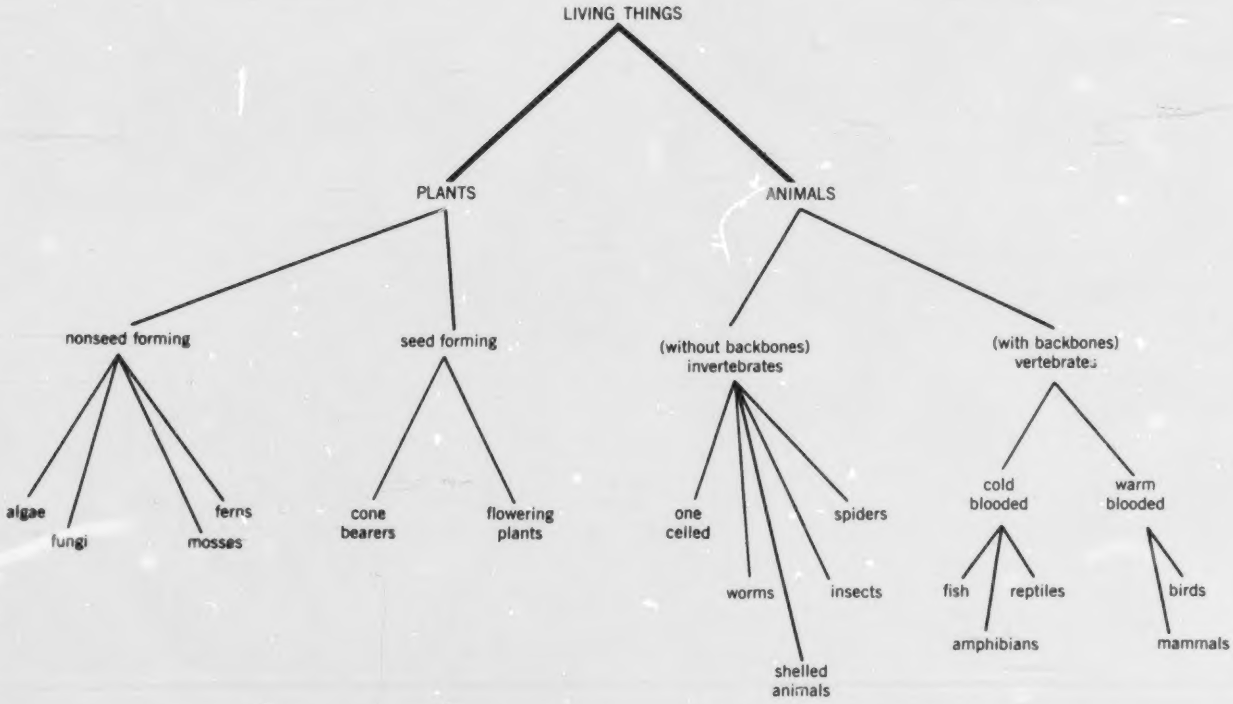
The grouping or classification of the paper figures can be related to the classification of living things by characteristics. The names of the various ranks of grouping in biological classification have been included in parenthesis in the example. If another set of figures were cut from aluminum foil, another class of figures would result. These two classes of figures grouped together form a phylum, one of the large divisions of biological classifications.

Children should be led to see from a study of the above classification that larger groups include smaller groups. Members of smaller groups have many characteristics in common, while larger groups are more diverse. However, all members of larger groups have certain characteristics in common.

5
The arrangement of books in the school library may be used as an example to typify the grouping of inanimate objects. Consider the situation that would exist if all books were placed on shelves in no particular order. How are books arranged so that they are easily located?

6
Call attention to the grouping of products in a supermarket. Any one of the groups can be separated into smaller groups. The grouping of the items keeps them orderly and aids in the location of them.

7
A simple introduction to biological classification is shown on the chart which follows. This chart shows only a few of the groups which should be familiar to sixth-grade children, and is not to be interpreted as being complete. Have the children extend certain branches such as " mammals " into dogs, horses, and cows. Note: When separating animals into groups having like characteristics, we must guard against giving them human attributes. Animals do not think or feel as we do (anthropomorphism).


LIVING THINGS
PLANTS
ANIMALS
nonseed forming
seed forming
(without backbones) invertebrates
(with backbones) vertebrates
algae
fungi
mosses
ferns
cone bearers
flowering plants
one celled
worms
shelled animals
insects
spiders
cold blooded
warm blooded
fish
amphibians
reptiles
birds
mammals

8

By the time children reach sixth grade, they should have enough experience to recognize the five common classes of vertebrates (animals with backbones). The characteristics listed below are simply stated and are by no means biologically complete. Some of the basic characteristics are given which distinguish each class and show how these vertebrates have developed into rather complex organisms. For example, fish, amphibians, and reptiles are all cold-blooded animals; therefore, this characteristic is not to be used to distinguish one group from the other.

Note: The term cold-blooded is not to be taken literally. A cold-blooded animal is one whose body temperature is controlled by its environment. When its surroundings get warmer, the animal becomes warmer; when its surroundings get colder, the animal becomes colder.

The basic characteristics of the five classes of common vertebrates are listed below in chart form for ease of reference. While it is not necessary for children to memorize the characteristics, it is desirable for the teacher to point out the differences in structures and characteristics which may be used to distinguish each of the various classes of vertebrates.

ANIMAL	HABITAT	REPRODUCTION	BODY COVERING	BREATHING	FEEDING AND CARE OF YOUNG	BODY TEMPERATURE	LOCOMOTION
Fish	Aquatic	Eggs deposited in water	Scales	*Gills (covered)	No care with most species	Cold-blooded	*Swim by means of fins
Amphibians	Aquatic and* moist land (both in one life cycle)	Eggs deposited in water or moist habitat	Warty or smooth moist skin	*Gills in larval stage; lungs in most adult stages	Generally no care	Cold-blooded	Hop, crawl, and swim during larval stages
Reptiles	*Land, in most species	*Shelled eggs hatched in body of female or on land by sun's heat	Dry, scaly skin	Lungs	Generally no care	Cold-blooded	Bipedal, quadrapedal, or crawl
Birds	Land, sea, and air	Shelled eggs on land or in nest by adults	*Feath[illegible]	Lungs	Considerable parental care	Warm-blooded	Winged flight in most species
Mammals	Land, sea, and air	Live born	*Hair	Lungs	*Presence of special milk-producing glands, [illegible]tended parental care	Warm-blooded	All methods

* Those characteristics which most readily distinguish one class from all others

Activities for children

1

Various kinds of animals without backbones (invertebrates) can be studied in the classroom. The children should have a variety of these animals available so they may observe the differences between invertebrates. Some may be grouped according to similar characteristics, such as insects, worms, and spiders. Have available some crickets, grasshoppers, butterflies, moths, ants, caterpillars, earthworms, leeches, spiders, crayfish, and centipedes. (Many others may be added to this list.) Note the main characteristics which distinguish invertebrates from vertebrates.

2

Examine a spider and some insect, such as an ant, to see how they differ. How is an insect defined? Why isn't a spider classified as an insect?

3
Butterflies and moths are similar yet different. Study each closely with a hand lens and note the differences.

4
Simple one-celled organisms can be studied with the aid of a microscope. See Grade 5 for suggestions. Compare these simple organisms to worms, insects, and more complex animals.

5
Obtain a fresh fish from the market. Look at the gills and gill covers. Look at the fins under a magnifier. Remove some scales and look at them through a microscope or a microprojector.

6
Compare the body covering of amphibians to that of fishes. Children will be able to study the development of the frog from egg to adult in much greater detail. Since this is one of the most spectacular phenomena in nature, it might be desirable to emphasize the changes which take place in this animal as it transforms from an aquatic dweller to a land animal. Specimens from each stage in the development of the frog may be removed from the containers daily and preserved in alcohol.

7
Reptiles generally have a dry scaly skin. While many children may fear, or be repulsed by, snakes, they should have the opportunity to hold a snake (one which is used to being handled) or touch its skin. It is not slimy, as some people think. Notice that turtles also have scales, the large ones being modified to form a protective shell over the bony body structure. If a turtle shell is available, look at the backbone. If children have the opportunity to observe a lizard, they will see how it differs from a salamander. There are many other interesting things to observe about reptiles, such as their feeding habits, movement, defense mechanisms, shedding of skin, and coloration.

8
Bring a large bird, such as a hen or pigeon, into the classroom. Find the distinguishing characteristics which separate birds from reptiles. Examine a feather closely. Look at the beak and feet. Can you find any part of the bird which may be similar to a reptile? Obtain some mounted specimens of a variety of birds from the high school biology teacher and examine their body structures.

9
Sometimes young birds fall from their nests soon after they have hatched. (Never remove young birds from the nest.) Compare their covering and external structure with that of an adult bird. Look for places on the body where feathers will begin to grow. Children will see that feathers grow only from certain places on the body. The high school biology teacher may have a preserved specimen which illustrates this point. Children can learn about the skeletal structure by examining young birds. Take the bird back where it was found and put it in a thick bush. If no bushes are nearby, put the bird in a perforated cardboard box, at least 12 inches deep. Fasten the box 8 or 10 feet above the ground. When the bird begins to cry for food, its parents will find it and care for it. Keep a parakeet or canary in the room for several days. Note how it uses its beak. Compare it with birds around the school. Are birds cold-blooded?

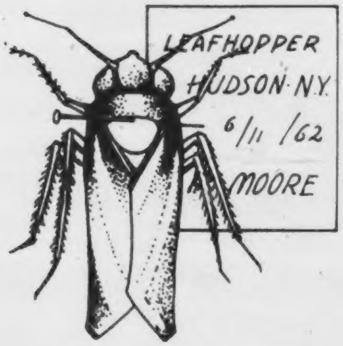
10
Children will probably be more familiar with mammals than the other classes of animals discussed. They will note some of the mammal characteristics in themselves. Discuss the presence of hair on the body. Do whales, sea lions, and porpoises have hair on their bodies?

11

It may be possible to obtain the skulls of some representative mammals. In rural areas, the skulls of many animals are available. Children living in cities may find skulls of small mammals in parks, vacant lots, or other places. The high school biology teacher may be able to supply a few. Examine the skulls of a mouse, woodchuck, raccoon, skunk, rabbit, opossum, and others. The skull of the rabbit and opossum will be particularly interesting. Many people consider the rabbit a rodent. However, upon close examination of this mammal's skull, two peg teeth will be found directly in back of the two upper front teeth (incisors). These are not found in rodents. Children can relate the tooth structure of animals to their feeding habits.

12

Make a collection of insects to preserve them, so that their structures can be examined and compared from time to time. They can be displayed in individual mounts, or collectively in cigar boxes or other suitable containers. To mount insects, hold the insect carefully between the fingers of one hand and insert the pin straight down through the thorax of the insect. The thorax is where the wings are attached. The diagram will help you decide where to pin various kinds of insects.



Do not insert the pin all the way to the head. Leave about one-third of the pin projecting above the back of the insect. This will provide a sort of handle for lifting the insect out of the collecting box for further study.

Below each insect, pin a label with the following information:

Name of insect, if known
Place
Date
Collector's name

This information should accompany each insect, regardless of whether or not the collector knows what the insect is. When the insect is later identified, the name can be added to the label. This is a good habit for young collectors to develop. Labeling insects may be the young scientists' first accurate record-keeping.

13

Make an insect collection by preserving soft bodied specimens in small vials of rubbing alcohol.

14

Make a collection of leaves in order to learn to recognize a few of our more common trees; include such trees as elm, sugar maple, white pine, hemlock, spruces, and others. Find out the difference between simple and compound leaves. Separate some examples into the two groups. Observe the difference in leaf shape. What does the leaf stem of a poplar tree or quaking aspen look like? As local trees are being identified, start a collection of pressed leaves. As fresh leaves are collected, place them between the pages of magazines to keep them flat. Wax each leaf by putting it between pieces of waxed paper and pressing it with a warm iron. Leaves treated in this way can be mounted in scrapbooks and kept in good condition indefinitely.

Notice that each kind of leaf has a vein pattern of its own. These vein patterns show up clearly on ink prints.

For ink printing, place a small quantity of printer's ink or linoleum block printing ink on a piece of glass or tile. Spread it to a thin even layer by rolling an art brayer back and forth across it. Then place a leaf, veiny side up, on several layers of newspaper and roll the inked brayer across it once. Pick up the leaf carefully and place it, inked side down, on a piece of clean paper. Cover it with a piece of newspaper and roll the brayer across it, pressing the leaf firmly against the printing paper. Remove the leaf carefully, and the print is finished

Good leaf prints can be made with carbon paper in the following manner. First cover the veiny side of a leaf with a very thin layer of lard or other kitchen grease. Place the greased leaf, veiny side up, on newspapers and cover it with a sheet of carbon paper. Cover the carbon paper with another sheet of paper and rub across this several times with the side of a round pencil. Remove the leaf, place it between two sheets of clean paper, and rub again with the round pencil.

The making of leaf prints and leaf silhouettes is valuable in developing manual skills and infixing firmly in mind the shapes and vein patterns of various kinds of leaves. The clearest and most perfect prints can be assembled and labeled to form a very attractive classroom exhibit. Many children will also be anxious to make collections of their own.

15
Have available a variety of seed-forming and nonseed-forming plants. Note the differences between algae, fungi, ferns, and mosses, using magnifying lenses. Among the seed-producing plants, compare evergreens and flowering trees.

16
Make mounted specimens of flowering plants for study by drying and pressing them. They not only make attractive displays but help children become aware of the differences among plant structures.

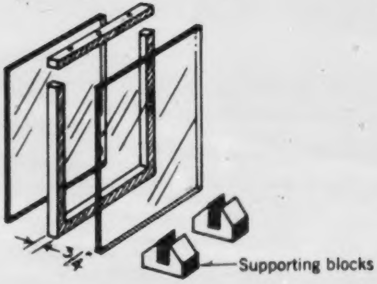
17
Speculate as to how a letter may be classified when it arrives at the local post office before it is sent on to its destination.

18
Obtain some bones of a bird; a chicken will do nicely. Do they feel light? How does this adaptation help a bird in flight? Compare it to a bone of similar size from another animal (weigh the bones). Cut the bone in half with a hacksaw. How does it differ from the other animal bones?

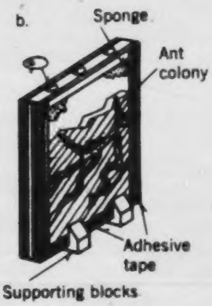
19
A formicarium (ant house) in the classroom will provide children with an opportunity to study a group of social insects. Note their structure and behavior. How do they make their home? Where do they keep their young?

An ant house can be made from two pieces of window glass and a wooden frame made of ¾-inch-square strips. Leave top of frame removable. Openings may be plugged with corks. Glass is taped to frame with adhesive tape. Cover glass sides with black paper or aluminum foil to keep the inside dark. Remove covering during observations.

a.



b.



To find ants for a formicarium, find an ant nest under a flat rock. Dig up nest with a trowel. Collect eggs, larvae, and pupae, as well as mature ants.

When back in the classroom, pour the mixture (ants, soil, and immature stages of ants) into the ant observation nest. Provide food and moisture for the ants. This can be done by keeping one of the sponges moistened with water and the other with a mixture of equal parts of honey and water. Supplement this diet with occasional flies and other insects, bits of bread and cake, fragments of bananas and apples, sugar, and bits of mashed walnuts. In a few days remove the cover from the nest and observe what the ants have done. Tunnels have been dug and some rearrangement of the soil should be noticeable. The larvae and pupae have been moved and collected by the workers into special places. Watch for ants going to the sponge for food and bringing it back to other ants in the nest. Since some of the pupae may be hatching, watch for the emergence of new ants. If a queen was gathered, notice how she is attended by the workers. If possible, watch her laying eggs. Ants are insects that exhibit what is called complete metamorphosis. There are four stages in their life cycle: egg, larva, pupa, and adult.

Fieldwork

1

The children will become more aware of the differences among plants if they can have field experiences. Visit an area having a variety of trees available to become familiar with their characteristics. Notice the shape of a tree, its bark, leaves, etc. During the spring, trips can be taken to observe the flowers and the dispersal of pollen income-bearing trees. Winter provides an excellent time to observe buds or trees and leaf scars. In fall children may collect tree seeds. They may also note what trees lose their leaves. The teacher can provide simple keys for the identification of trees. These not only aid in identification, but will make children aware of structural differences in trees which determine their classification. Note: The term "evergreen" as applied to trees is too often taken literally, thus creating misconceptions in the minds of children. In most instances, cone-bearing trees lose their leaves gradually, thus appearing ever green. However, not all cone bearing trees remain "evergreen" (the larch, for example) and not all evergreens are cone-bearing. Yews and cedars produce berries instead of cones.

2

Take trips to collect and identify plants. Ferns, mosses, and flowering plants may be collected, dried, and pressed. While in the field, specimens can be kept pressed between sheets of newspaper and cardboard.

3

The feasibility of visiting a variety of habitats depends upon the location of the school. Some of the suggested places to visit would be a forest, pond, marsh, swamp, stream, meadow, garden, shore, or schoolyard. Pupils can take a habitat census of plants and animals they see or record evidences of animal life. Make notes or sketch pictures of new organisms which cannot be identified on the spot, and look them up upon return to the classroom.

4

Field trips can be taken to collect fish, amphibians, insects, and other animals for use in the classroom. A simple net at the end of a pole will be very useful. Since there are game laws which restrict the collection of certain fish, mammals, and turtles, it is desirable to check with a local game protector of the State Conservation Department before going on a collection trip.

5

Take a trip to a museum to observe animal habitat groups. Note the plants and animals which occupy a particular habitat. Most museums also have displays relating to animal structures and the classification of living things. The museum is an excellent instructional resource to supplement and enrich classroom and field activities.

6

Undoubtedly many children will have visited a zoo before they reach sixth grade. However, a zoo is a good place to observe the structures of animals which are the basis of animal classification. Observe how they move, their color, and other characteristics. Find out which animals belong to the same family. Observe examples of the five common vertebrates.

7

Go on a bird walk in the spring. Take a bird census; see how many different kinds can be identified. Separate the birds on your list into similar groups, such as sparrows, blackbirds, songbirds, and hawks. See if you can tell the difference between two sparrows. Note the flight pattern, song, shape of beak, color, body movements, and other habits.

8

A nature or wildlife sanctuary is an excellent place to look for birds. Because it is under protective custody, pupils will undoubtedly see a greater variety of species than under natural circumstances. In addition, an undisturbed habitat may be observed. Such a place is ideal for combining the bird trip with the identification of plant life and observations of other animal forms.

ENRICHMENT

Questions to stimulate further thought

1. How many reasons can you find as to why beavers gnaw on trees?
2. According to fossil records, which class of animals appeared on earth first, the fishes or amphibians?
3. If an insect has no bony skeleton, how does it keep its shape?
4. Who was Charles Darwin? What did he believe after he sailed around the world? Read and report on his trip around the world.
5. Many organisms have evolved into rather complex organisms. Which living animals have remained quite simple and have undergone little or no change in millions of years?
6. Some prehistoric relatives of the ferns, ground pines, and scouring rush once grew to the height of trees. What were conditions on earth at the time these prehistoric plants grew so tall? How do you account for their present-day size?
7. How do aquatic mammals, such as the whales, dolphins, porpoises, and seals, breathe?
8. How long have mammals lived on earth? reptiles? fish? amphibians? birds?
9. Are all animals capable of movement?
10. What are sharks? Are they fish? How are they classified?
11. Do invertebrate animals have a circulatory system?
12. Why isn't the opossum grouped with the meat-eating animals, such as the dog, cat, raccoon, and bear?
13. Would our system of classification of living things be satisfactory on another planet?
14. Do you suppose early man classified living things? Why?

Topics for additional exploration

1
Fish scales. The scales of all fish are not alike. Through the use of a microscope, they can be used as an aid to identification and also to determine the age of a fish. The scales appear in rows on the side of the fish; the number of scales is the same for a particular group of fish. The scales of fish become larger as the fish grows, with the growth rate slowing down in the winter time. A scar results when growth slows down and serves as an indication of age for some fish.

2
Hearing in fish. Although fish do not have ears, they do respond to sounds in the water. How is this possible?

3
Biological classification. In order for biologists to study living things with any order, it has been necessary to classify plants and animals. The system used today is based on the method popularized by Linnaeus during the 1700's. A biology text will describe the system.

4
Conservation of wild flowers. Many of our wild flowers are protected by conservation laws. Find out which ones are protected, how they are protected, and why they are protected. Are there certain groups of wild flowers that are particularly in need of protection?

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ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make charts which illustrate the various types of birds' bills. Label them according to the food habits of birds; include seedeaters, birds of prey, and others.

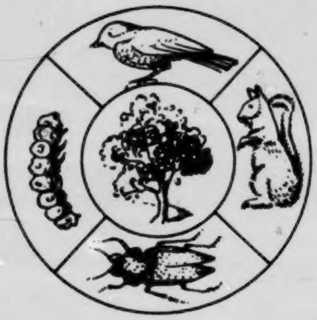
2
Make similar charts which show the different types of foot structure in birds.

3
Draw a large diagram of an ant on chart paper, to represent a typical insect. Label the parts. The same can be done for fish and other animals.

4
Make flash cards by cutting out pictures ot animals or plants, and pasting them on oak tag or cardboard. Invent games to be played with the cards.

5
Start a classroom or school museum. Temporary exhibits may be obtained from the high school biology teacher or on loan from a museum. More permanent exhibits can be made by children, such as insect collections, simple preserved specimens, dioramas, and charts. Include devices which can be manipulated by visitors, such as a choice board. The pupils will serve as curators and guides. Label the exhibits and make museum cards with short explanations of the displays.

6
Make dioramas of habitat groups which depict plant-animal relationships. The materials needed include a sturdy rectangular cardboard carton, oak tag, or some other stiff drawing paper which will serve as a curved background after it has been painted, clay for figures and other objects, and tempera paints for finishing touches. If the effect of a glass front is desired, a sheet of cellophane can be pasted over the front. A cross section view of a woodchuck burrow would make an interesting diorama.



7
Individual pupils or groups may work out habitat wheels centered upon different habitats, such as a pond, a brook, a bog, a garden, a swamp, or an individual tree. A picture of a habitat is drawn or pasted within a circle. In a larger circle surrounding the habitat, pictures of animals that live in it can be drawn or pasted. For example, a tree surrounded by a bird, insect larva, fungi, squirrel, and beetle would illustrate one type of habitat. The development of such habitat wheels calls for considerable research and checking on the part of pupils.

8
Terrariums or bottle gardens can be made with gallon pickle or mayonnaise jars. Lay the jar on its side; shape two pieces of modeling clay or wood into the form of a small cradle to keep the jar from rolling. Put a little gravel in the jar; cover it with soil and leaf mold collected from the woods. In some instances, soil can be obtained from greenhouses. Small conifer seedlings, partridge berry, wintergreen, and mosses are suitable plants for such a terrarium. Small household plants such as begonia, African violet, and coleus have been used successfully in these gardens. Try different types of terrariums, such as bog, desert, and semiaquatic ones. Small salamanders, toads, and other animals may be kept in such containers for a short time. The end of the container can be covered with cellophane or plastic wrap.

9
Animal cages, terrariums, aquariums, and other containers may be used to house animals for a classroom zoo. Each exhibit should be properly labeled with a small card describing the inhabitants of the container. Such information might include the name, where found, type of habitat, fallacies concerning the animal, and conservation measures.

10
Make a mural which illustrates the evolution of animals from simple to complex organisms. Separate each into categories by characteristics which distinguish them from other organisms.

11
If a small whole chicken is boiled for a considerable time, the meat will easily fall off the bones. The bones can be cleaned, dried, and then assembled with household cement and wired into their original positions. Such an assembled skeleton will be useful for years.

Questions to guide a summary of experiences

1. Why have living things been named?
2. How are living things grouped? For what purpose?
3. What is the basis for classifying living things?
4. How have living things developed? How long has it taken?
5. What is meant by the interdependence of living things?
6. What is the most important trait that distinguishes humans from all other mammals?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Scientists have arranged plants and animals into similar groups in order to study them.
2. Classification of living things is based on their structure.
3. Classification emphasizes the development of simple forms of life into more complex forms.
4. Living things have developed into complex organisms very slowly during millions of years.
5. Many different kinds of plants and animals live together in nature and depend on each other for food.

VOCABULARY

amphibian
biological
characteristics
classification
cold-blooded
conifer
evolved
gill
interdependence
invertebrate
key
label
mammal
metamorphosis
organism
protozoa
reptile
rodent
scale
species
structure
trait
vertebrate
warm-blooded

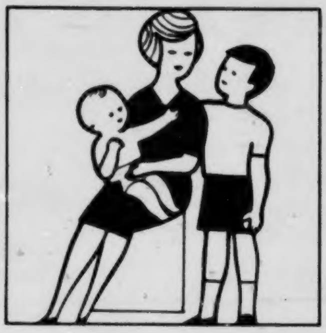
SCIENTISTS

Agassiz, Louis
Darwin, Charles
Gray, Asa
Huxley, Thomas
Jordan, David Starr
Linnaeus, Carolus
Simpson, George Gaylord

Sixth Grade

b OUR GROWING BODIES

PHYSICAL FITNESS



PURPOSE OF THE UNIT: ***to acquaint the pupil with the meaning and purpose of physical fitness and the way to achieve fitness***

Apparatus and materials

1. Double clamp
2. Eyedropper
3. Femur clamp
4. Fine wire
5. Frog gastrocnemius
6. Inductorium and batteries
7. Kymograph and paper
8. Muscle lever
9. Ring stand
10. Small beaker of frog Ringers solution
11. Spirometer
12. T-arm
13. Weight pan
14. Weights, 10-gram
15. Wires

INTRODUCTION OF THE UNIT

Motivating activities

1

The pupils may prepare a bulletin board on training using newspaper and magazine stories about college and professional athletes, Olympic team aspirants, or local high school team training programs.

2

The pupils may bring into the classroom for reading, or read in the library, stories of great athletes such as Clarence DeMar, Stan Musial, Herbert Elliott, or others of the past and present.

3

From material available, such as the New York State Physical Fitness Test and the test recommended by the President's Council on Youth Fitness and other sources, the pupils can prepare a bulletin board showing ways to test physical fitness.

4

A visit to a paddock or horse farm where racehorses are trained will give evidence of the importance of strenuous exercise in the training of horses for race competition.

Motivating questions

1. Why do we want to be physically fit?
2. Do we need to be physically fit?
3. For what reasons do we need physical fitness?
4. When we say " physically fit," exactly what do we mean?
5. What does strength have to do with physical fitness?
6. Why is a strong heart necessary for a high level of physical fitness?
7. How can we measure physical fitness?
8. How can we measure heart power?
9. What does fatigue have to do with physical fitness?
10. If you are physically fit, how do you feel?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1

The teacher may show the class by demonstration with frog gastrocnemius that muscles do work, that they get tired and cannot do as much work as formerly, and that a muscle is revived by rest. The use of Ringers solution shows that fatigue products must be carried away from the muscle. All textbooks of biology and physiology have material relating to this experiment, and detailed descriptions of the conduct of the experiment.

2

A simple basic law of physics defines a foot-pound of work as weight (in pounds) x distance (in feet). It should be easy to select an obviously strong boy, one who is obviously less strong, and have each of them lift 25 or 50 pounds from the floor to the top of a desk. The comparative ease with which the stronger boy did an amount of work equal to that done by the less strong boy will be apparent. The foot-pounds of work done is easily measured with accuracy; the energy expended is not so readily measured.

The onset of fatigue can also be visualized by having the boys lift the weight up and down a number of times. This is a parallel to the experiment previously performed with the frog muscle.

Increase in heart rate and breathing rate can also be used to further illustrate the need for oxygen and food to carry on muscular activity.

3
Have each pupil in the class tie a weight on his finger. With the weight attached, have the pupils contract their fingers until they cannot contract them any more. Allow rest, then let them try again. This also illustrates personally what the frog muscle illustrated experimentally.

Activities for children

1
Most physical education departments have copies of the record "Chicken Fat" (available from Junior Chambers of Commerce); children enjoy doing the prescribed exercises to this music. The physical education teacher will be happy to let these pupils experience this record and the accompanying fitness exercises.

2
The physical education department will be glad to cooperate in administering a fitness test to the boys and girls in the grade. The results of the test may be posted in the classroom. If the test has already been given, then the results alone can be used without the testing procedure.

3
A very interesting and illuminating test of physical fitness can illustrate the part the heart plays in fitness. Using a modification of the Harvard Step Test for only 1 minute will illustrate the action sufficiently. Have one or more pupils step up on a bench 16 inches high; using a 4-count step, have the pupil perform 30 steps or approximately 1 minute of exercise. The 4 count means stepping up on the bench with one foot on 1; bring the second foot to rest on the bench on 2; step down to the floor with one foot on 3; and bring the second foot to the floor on 4.

By counting the pulse before the exercise, immediately following the exercise, and after sitting down for 1 minute following the exercise, the amount of increase would indicate how hard the heart had to work to supply food and oxygen to the heart and carry waste products away.

Fieldwork

1
With scores made on the fitness test available, several of the boys and possibly some of the girls would be willing to select one of the items on the test to practice every day at home. Once a week, or every 2 weeks, the new score attained on the item could be recorded and the gain noted.

2
From research which the pupils could carry on, a chart showing "Things To Do for Physical Fitness" could be made and exhibited in the room or other classrooms.

3
The class could easily visit a practice session of a varsity team (football, soccer, track, etc.) and watch the team during the conditioning part of the program. A discussion in the classroom of the things observed could be held following the visit. The discussion would stress the "why" of the exercise program.

ENRICHMENT

Questions to stimulate further thought

1. What happens to people who are not physically fit?
2. What are the things which keep us from becoming physically fit?
3. Will exercise alone make us physically fit?
4. Does physical fitness help us avoid illness?
5. Do both boys and girls need physical fitness?
6. Athletes need to be physically fit, but do nonathletes need it also?

Topics for additional exploration

1
Lung capacity. Using a spirometer, tests of lung capacity can be given. From this start, pupils may explore the relation of lung capacity and breathing to fitness.

2
Total fitness. Have the class, through research, find the difference between physical fitness and total fitness.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Collect and exhibit names of men who are, or have been, famous as a result of their remarkable fitness.

2
Construct a chart listing names of famous doctors who urge fitness for everyone.

3
Hold a " Sixth Grade Quiz Bowl " on the subject of physical fitness. Either the teacher, or the teacher with a small committee, can plan the questions to be asked during the quiz.

4
Drawings can be made for the bulletin board which will depict the various exercises recommended to produce strength and fitness.

5
The class can construct lists of activities which contribute most to fitness, those which contribute least and those which are actually detrimental to physical fitness.

6
Construct a " static " exercise bar for the room so it may be used by any pupil who may wish to increase his strength.

Questions to guide a summary of experiences

1. Can we attain physical fitness without exercise?
2. What are some ways of measuring physical fitness?
3. Is exercise all we need to achieve fitness?
4. Give reasons why everyone needs to be physically fit?
5. Why do we need rest and sleep if we wish to be physically fit?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. To achieve physical fitness, there is a need for strenuous physical activity.
2. Physical fitness helps us do most everything we try easier and better than when we are not physically fit.
3. Food, rest, and sleep are important helps in achieving physical fitness.
4. Physical fitness ultimately depends on how strong the heart muscle is, because we depend on it for oxygen and food in the cells and for taking away waste products.
5. Increase in strength of all muscles, including the heart, depends on exercise.

VOCABULARY

- achieve
- capacity
- conditioning
- contraction
- contribute
- detrimental
- exercise
- fatigue
- femur
- fitness
- foot-pound
- gastrocnemius
- gram
- inductorium
- kymograph
- muscle
- physical
- pulse

Sixth Grade

C AIR, WATER, AND WEATHER

THE ATMOSPHERE WEATHER CHANGES

PURPOSE OF THE UNIT: ***to become aware of some of the factors related to weather changes and how these conditions are measured***

Note: Any school would do well to consider the purchase of a subscription to daily U.S. weather maps. These large and clear maps are printed each day by the U.S. Government Weather Bureau and can be used by schools in many different ways. A subscription can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The subscription rate is $2.40 for 3 months or $9.60 per year. For cloud charts and other material relating to the teaching of weather, request price list No. 48. A Weather Science Study Kit is also available from the Weather Bureau; this kit contains 16 pages concerning instruments, satellites, lightning, etc. The order number of this kit is C-30.78: W37 and the cost is $1. Order forms are available through the Superintendent of Documents.

Apparatus and materials

1. Beakers
2. Bimetallic strip
3. Bunsen burner
4. Clamps
5. Cobalt chloride solution
6. Demonstration aneroid barometer
7. Flask
8. Glass tubing
9. Hygrometer
10. Medicine dropper
11. Mercury
12. One-hole rubber stopper
13. Pans
14. Rain gauge
15. Rubber cement
16. Small dish
17. Small mirror
18. Standard rod
19. Thermometers
20. Thin rubber sheeting
21. Wide-mouthed jars

INTRODUCTION OF THE UNIT

Motivating activities

1
Call pupils attention to radio or television weather reports. Post daily and long-range weather forecasts on the bulletin board.

2
Display some weather instruments.

3
Arrange a bulletin board of pictures and articles concerning weather satellites.

4
Post the weather maps from a newspaper on the bulletin board each day for at least a week. Can the pupils discover any patterns or relationships among these maps? How does the weather outside compare with the information given by the maps?

5
Obtain a barometer and have the air pressure recorded each morning and afternoon. Record these readings and construct a large bar graph which will show the fluctuations during a week's time. (Limit the vertical scale to read between 29 inches and 30 inches.)

Motivating questions

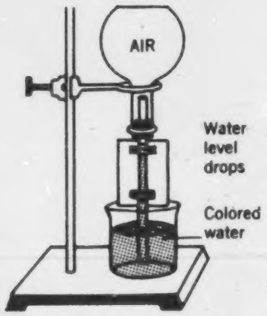
1. What is weather?
2. What kind of weather are we having today?

   Note: The terms "weather" and "climate" should not be used synonymously. Weather is the condition of the atmosphere at a given place and time. Climate is the average weather condition over a period of time.
3. What instruments are used in weather prediction?
4. Why is weather forecasting important?
5. What will the temperature outside the window be tomorrow at this time?
6. What people are most interested in weather predictions?
7. What is the Weather Bureau?
8. What is a meteorologist?

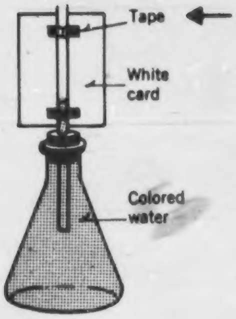
EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
A simple, yet important condition of the air is its temperature which is measured with a thermometer. Nearly all thermometers operate on the principle that the materials, whether liquid, solid, or gas, tend to expand when heated and contract when cooled.

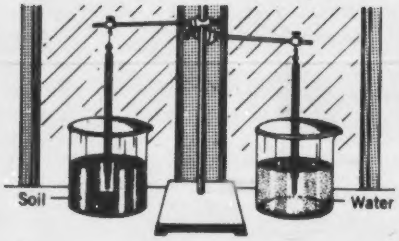


a. To demonstrate the operation of a gas thermometer, insert a glass tube through a one-hole rubber stopper and fit it in a flask. Invert the flask and tube in a beaker of colored water as illustrated. To make the colored water rise part way up the tube, hold the palms of the hands around the flask until it warms. As the flask warms, the air inside it will warm, expand, and bubble out of the opened end of the submerged tube. Release the flask and allow it to cool to room temperature. As air in the flask cools and contracts, the water will rise up the tube. Tape a blank white card to the tubing as shown. Present this thermometer to the class. By use of the hands, warm the flask and have the children note the change in the liquid level in the tube. Ask: "Why does the liquid move up and down?" Have the children determine a method of calibrating the card so that direct temperature readings can be taken from the instrument. Will air pressure affect the reading?



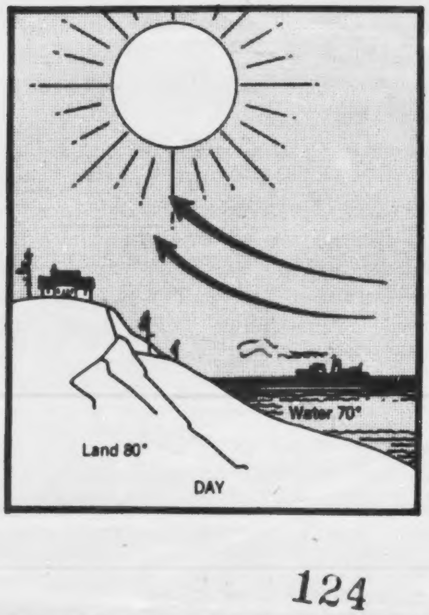
b. Liquid thermometers operate on the same basic principle as gas thermometers, except that the expansion rate of the liquids is not as great or as rapid as the expansion rate of gases. The diagram shows how a flask, a rubber stopper, and a glass tube can be assembled to make a liquid thermometer. Present an uncalibrated thermometer of this type to the class and have them determine how it can be calibrated. A simple method of heating and cooling the flask of colored water is to set it alternately in pans of hot and cold water. Will air pressure affect the readings?

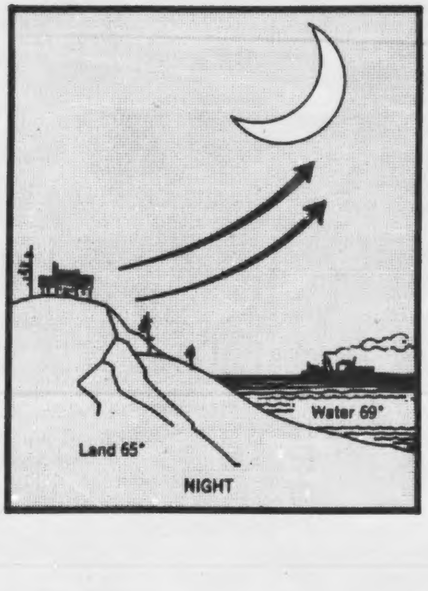
c. Some thermometers operate on the principle that solids expand and contract with temperature changes. Usually a metallic bimetal strip is used. Hold a demonstration bimetallic strip in a burner flame, and have children observe its action. Allow it to cool in the air or dip it in cool water. The strip is actually two thin strips of metal which have been joined together. One of these metals expands greatly when heated, and the other metal expands only slightly when heated. Such uneven expansion forces the bar to assume a curved shape when heated. Bimetallic strips are often used in oven thermometers. Remove the back from an inexpensive oven thermometer, and have the children watch the action of the strip when a burner flame is pointed at the thermometer.



2
The atmosphere heats up only slightly from the sunlight that passes through it. Most of the heat in the air is absorbed by its contact with the warm surface of the earth. The unequal heating of the land and water results in unequal heating of the atmosphere, which in turn, results in winds. (See grade 3.) To show the unequal heating of soil and water, place some soil in a beaker and fill another beaker to the same level with water. Support a thermometer in each beaker, as illustrated.

Place both beakers in a shaded place in the room until their temperatures are the same. Then put the containers in the direct sunlight, and read the thermometers at 10 minute intervals for an hour to determine which heats faster. Relate the observations to the heating of the earth's surface. Return the beakers to the shade to determine which cools faster.



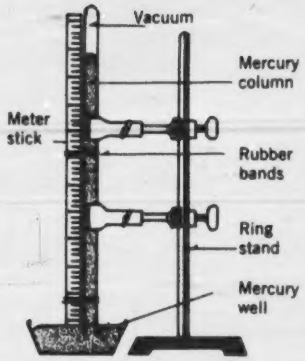


3

Collect a number of thermometers which are designed for use in the home. Place them side by side on a table. Do they all register the same temperature? Which one is really right? Place them all in a beaker of ice water. Observe readings. Repeat in a beaker of warm tap water. Discuss these differences in readings. Are such inconsistencies important in our daily lives? To a baker? To a scientist? To a farmer? Is a thermometer useless if its scale does not indicate the correct temperature?

4

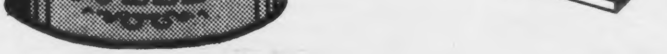
Because air has weight, it presses on the surface of the earth. This phenomenon is known as atmospheric pressure. Since air in the troposphere is constantly in motion, the air pressure keeps changing. It is sometimes possible to predict the weather by noting whether the air pressure is increasing (often indicating good weather) or decreasing (sometimes indicating stormy weather). Barometers generally operate on one of two principles. Some use a column of liquid which is supported by air pressure, while others utilize a sensitive mechanical system which is squeezed by the pressure of the air.



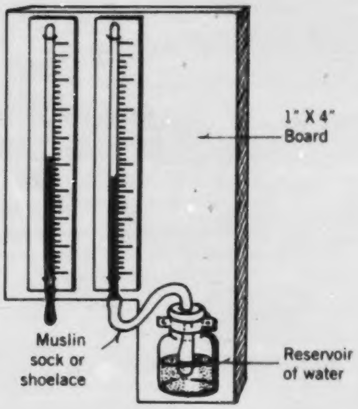
a. To construct a mercury barometer, obtain a glass tube at least 33 inches long sealed at one end. Using a medicine dropper, fill the tube with mercury while holding the tube at an angle of about 45° to prevent the trapping of air bubbles in it. Place your finger over the open end of the tube, invert the tube, and stand it in a small dish of mercury. Mount a yardstick or a meter stick beside the tube, as shown in the illustration. If assembled carefully, the mercury will be held up in the tube by the air pressure to a height of about 28 to 30 inches. Observe the barometer from day to day. As the air pressure increases, it will push down on the dish of mercury and raise the level of the liquid in the tube. With a decrease in air pressure, the level of the mercury in the tube will drop. If water were substituted, the tube would have to be about 33 feet long.

b. Use a demonstration aneroid barometer to show the children how the mechanism responds to changes in pressure.

c. If a demonstration aneroid barometer is not available, a simple aneroid barometer can be constructed from an *unopened* can of vacuum-packed coffee. Glue one end of a long broom straw to the center of the lid of the can, as illustrated. Set up a cardboard scale at the other end of the straw, with fine markings which are either numbered or lettered. From day to day, small fluctuations will be noted as the changing air pressure forces the lid of the can down differing amounts.



5
The anemometer and wind vane are easily explained with demonstration models made for the purpose. Ask the children such questions as: "Why is the tail on the wind vane always larger than the head or arrow?" and "Why are cups used on the anemometer rather than flat surfaces for the wind to push against?" If demonstration models are not available, models can be constructed as described in the third-grade unit.



6
In order to explain how the hygrometer is able to measure the humidity or moisture in the air, it will be necessary to first review a few concepts with the children. When water evaporates it produces a cooling effect. Perhaps it would be worthwhile to refer to the Second Grade. "Air, Water, and Weather" unit. The children should also understand that the drier the air is, the more rapidly water will evaporate into it. Using a simple hygrometer, sometimes known as a wet-dry bulb thermometer, show how one bulb is kept wet with a wick. As the water evaporates from the wick it cools the "wet" thermometer, and lowers the temperature reading. If the air is very humid, water evaporates slowly and the two thermometers will read just about the same temperature. If the air is very dry, evaporation is rapid, the cooling effect is great, and the two thermometers indicate quite different readings.

Record the temperature of the dry bulb thermometer, and the difference between the wet and the dry bulb thermometers. Using these two figures, find the relative humidity with the table at the end of this unit. For more accurate results, fan the hygrometer before taking readings.

7
The easiest and clearest way to explain the operation of a rain gauge to the children is to show them one. Point out that the opening of the collection tube is much wider than the measuring tube. Note also that the scale on the measuring tube is enlarged to compensate for the difference. Why are rain gauges constructed in this manner?

8
For the following activity, the daily U.S. Government Weather Bureau maps are ideal, but the maps from a daily paper will do if they show high and low pressure areas. Post weather maps for 5 successive days. Locate a low pressure area in the western part of the first map. Color in this "low" with a red crayon. Locate this same "low" on the next map and again color it red. Repeat for the remaining maps. The class will be able to see that the general movement of weather is from west to east.

9
Study the various symbols used in our weather maps. Have the children draw a station model of the weather they can observe outside; include in the station model the cloud cover, wind direction, wind velocity, and temperature.

10
After an understanding of weather prediction has been developed, have the class observe the temperature, barometric pressure, wind direction, and cloud cover. From these data, let them try to predict tomorrow's weather. Continue this activity for a few days. Record successes and failures. Following these predictions based on personal observations, try to predict tomorrow's weather by looking at a U.S. Weather Bureau map. Remind children that our weather generally moves from west to east. Are the predictions that are based upon the map more successful? Why?

Activities for children

1

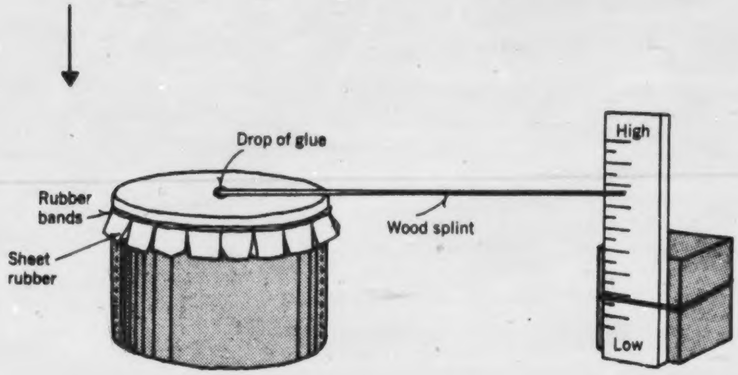
Supply the children with thermometers such as those sold for use outside windows at home. Have the children record the temperature on their desks, on the windowsills in the direct sunlight, in a pan of warm water, in ice water, and in a mixture of salt water and crushed ice. Have them record the temperature outside in the shade and in the sun. Have them compare temperatures on the surface of a blacktopped area with that on a concrete area. Be sure that glass bulb touches the surface being measured.

2

Record the outdoor temperature in the morning when school opens, at lunch time, and just before afternoon dismissal. Do this for 5 consecutive days. Is there a pattern? At what time of the day does the highest temperature occur? Is this when the sun is highest in the sky?

3

The operation of an aneroid berometer can be understood by constructing a simple model. Have the children bring in wide-mouthed jars. Stretch thin rubber sheeting over the mouth of the jar and fasten it very securely with rubber bands so no air can get in or out of the jar. Using a drop of rubber cement or a strip of tape, fasten the end of a long broom straw to the center of the rubber sheeting. Make a scale as illustrated and place it behind the end of the pointer. The children can demonstrate what happens when the air pressure increases by pressing their fingers on the rubber. Note: The teacher should realize that since the jar is filled with air, this instrument will also operate as a thermometer as the enclosed air expands and contracts with temperature changes. It is for this reason that aneroid barometers have a flexible chamber which has been evacuated.

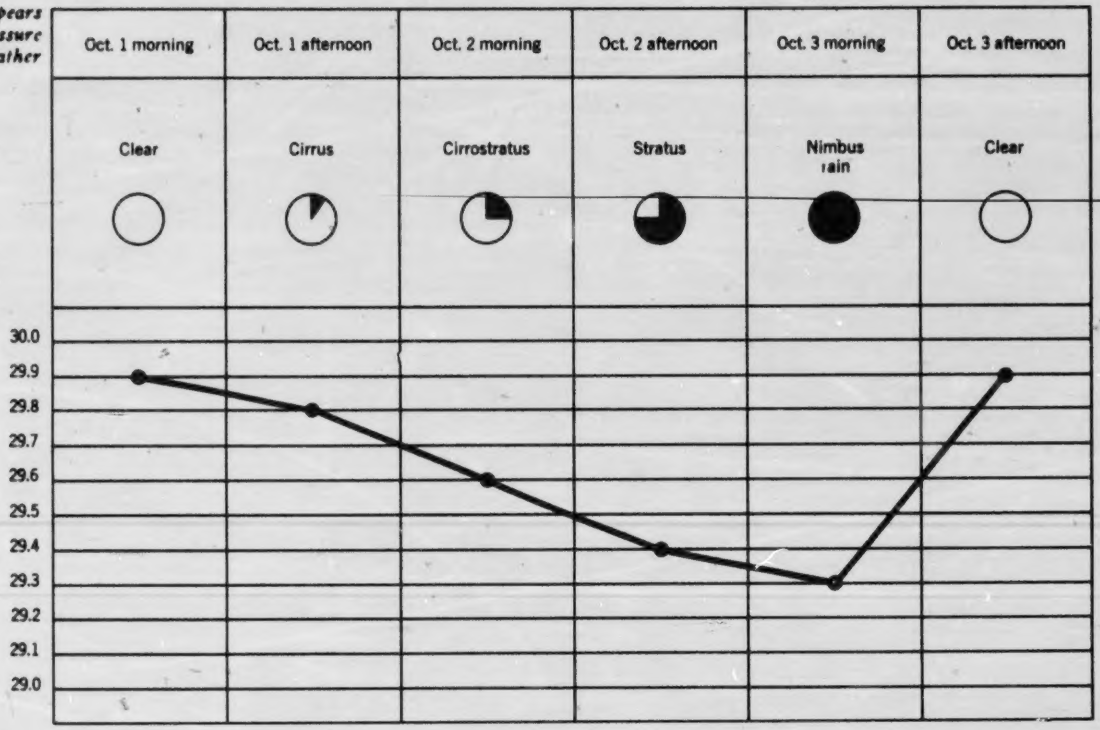


4

The children can make a simple chemical hygrometer; they will be fascinated by its action. Cut out simple shapes or designs (flowers and umbrellas are appropriate) from white cloth, such as old sheeting. Soak these pieces of cloth in a solution of cobalt chloride which can be obtained from the chemistry teacher, a science supply house, or the local drugstore. Hang the cloth designs up to dry, and then glue them to cardboard backing or tack them to the bulletin board. When the air is humid, the chemically treated cloth will turn pink, and when it is dry, the cloth will turn blue.

5
Establish a class log for recording air pressure and the observed weather. Record data at the beginning and end of each school day for at least 1 week. Include the date, barometer reading, amount of cloud cover, kind of clouds, and precipitation if any. Make a graph of the data collected.

What relationship appears between barometric pressure and the observed weather conditions?



Fieldwork

1
Arrange to make a visit to the nearest weather station. Frequently many local weather bureaus are located at airports. Find out about the instruments which are used by meteorologists. How do meteorologists make daily and extended forecasts? Note their maps and communications equipment. From what source do the local radio and television reporters get their weather information?

ENRICHMENT

Questions to stimulate further thought

1. Why is it that the barometer registers less pressure as the air gets more humid?
2. How is radar used to predict the weather?
3. Who pays for the operation of the U.S. Weather Bureau?
4. What is the difference between absolute humidity and relative humidity?
5. How many quarts of water are normally in the classroom in the form of water vapor?
6. Why is mercury sometimes used in thermometers when colored water would be much cheaper and easier to see in the glass tube?
7. What is the red or blue liquid that is commonly used in thermometers? (Mercury is a silver liquid and cannot be colored.)
8. How cold is twice as cold as zero?
9. What government agency first organized a unit for weather forecasting?

10. How did early man attempt to influence and change the weather? Does modern man still attempt to change the weather?
11. Who was Aeolus?
12. What is the jet stream? How does man use it?
13. Why does the troposphere extend higher above the earth over the equator than it does over the poles?

Topics for additional exploration

1
The development of the Fahrenheit temperature scale. How are the points of 0°, 32°, and 212° established?

2
Radiosondes. These miniature weather stations carried high up into the atmosphere are of great value in weather forecasting.

3
Temperature records. Find the hottest and coldest temperatures ever recorded on earth. What is the record high and low temperature for your town or city?

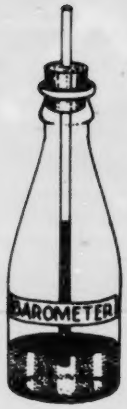
4
Weather satellites. In what ways are weather satellites useful to the meteorologist in the process of weather prediction?

5
The Beaufort scale of wind speed. The U.S. Weather Bureau uses the wind barb decimal system to denote wind speeds. This is a modification of the Beaufort scale of wind speed. All wind instruments are expressed in terms of nautical miles per hours.

6
History of the U.S. Weather Bureau. The U.S. Weather Bureau was founded in 1870 as a part of the U.S. Signal Service.

7
Sling psychrometer. The wet and dry bulb thermometer which is used to measure relative humidity.

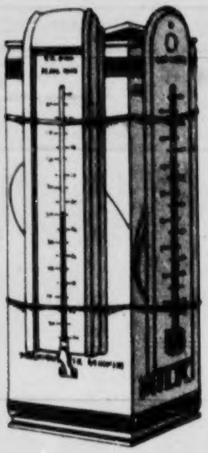
8
Methods of prediction. Keep a daily record for at least 2 weeks which shows each day's weather as: 1. it actually appears; 2. it was predicted by the paper; and 3. it was predicted by an almanac.



Keep at uniform temperature

ORGANIZATION AND USE OF INFORMATION GAINED

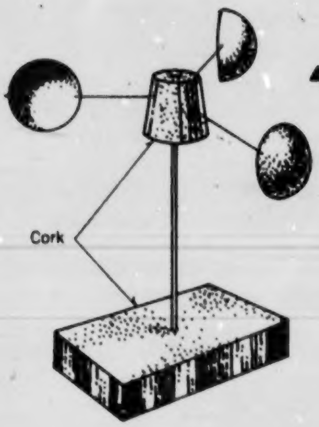
1
The "soda bottle" barometer shown in the diagram will indicate changes in atmospheric pressure. However, since there is air in the bottle, the instrument will act as a thermometer unless it is kept at a uniform temperature. In order to more easily notice the changes in height of the colored water in the tube, calibration marks can be placed on the side of the tube. To do this, make a number of scratches on the tube with the corner of a fine file. Rub some lipstick or crayon over the scratches and then wipe the tube clean with a soft cloth. The red coloring will remain in the scratches.



2

A hygrometer can be made by using two inexpensive thermometers and a shoelace. The two thermometers should register very clearly the same temperatures when placed side by side, or the difference must be considered a constant that is a part of all computations. Cut a 4-inch section from the cotton shoelace and slip it over the bulb of one of the thermometers. Tie it with thread above and below the bulb to hold it in place. Place the other end of the shoelace in a small bottle of water. The hygrometer may be fanned before reading for more accurate results.

When the shoelace is wet, the evaporation of the water will result in a cooling of the "wet-bulb" thermometer while the "dry-bulb" thermometer will continue to read the temperature of the air around it. The relative humidity can be determined by recording the temperature of the "dry-bulb" thermometer, the difference between the readings of the two thermometers, and applying these to the table printed at the end of this unit.

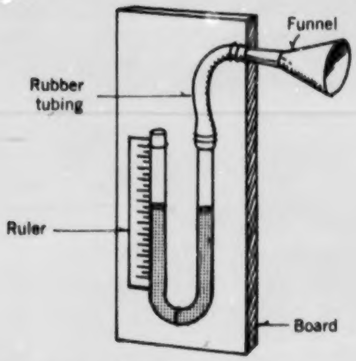


3

The anemometer illustrated can be constructed from a cork, Ping-Pong balls, cotton swab sticks, a knitting needle, and a short piece of glass tubing. Close one end of a short piece of glass tubing by rotating it in the flame of a burner until it seals itself. Drill a hole in the cork and insert the closed end of the glass tubing. This will form the bearing surface for the point of the knitting needle. Drill holes in the halved Ping-Pong balls, so that the sticks can be pushed through them and held with a drop of glue. If one of the anemometer cups is painted black, it will be easier to count the number of revolutions per minute made by the instrument when it is turning in the wind.

4

A pressure-tube anemometer then can be constructed as illustrated. A piece of glass tubing about 18 inches long can be heated in a burner flame until it is soft and then bent into the required "U" shape. To demonstrate its preparation, hold the instrument in front of a three-speed electric fan. Vary the fan speed and note the different heights of the level of colored water in the tube.



5

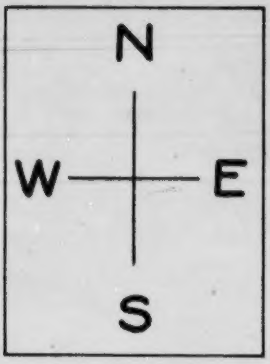
Make a weather observation chart. Include such headings as date, barometer reading (include direction: whether barometer is steady, rising, or falling), temperature, wind speed, wind direction, cloud cover, and precipitation. Record daily conditions for an extended period of time. Data may be obtained from reports in the newspapers, on the radio, or on television.

6

Collect calendars and almanacs that give weather predictions for every day of the year. Post these predictions and check them from day to day with actual conditions. Have the children consider how such predictions must have been made. Also point out the fact that the United States is so large that the weather cannot be the same all over the country, yet the almanacs are distributed nationwide.

7

Make a collection of weather sayings which people sometimes use to predict the weather, such as: "Red sun at night, sailor's delight; red sun in the morning, sailors take warning," or "Rain before seven, clear before eleven." Make predictions based on a number of these sayings and check results with actual weather conditions over a period of time.



8
A nephoscope can be constructed and used to observe cloud movement as a method of determining wind direction at high altitudes. The nephoscope is a simple indicator made from a small mirror. Find the center of the mirror and draw crossed lines with a grease pencil or model airplane paint. Label the points of the compass on the mirror's edge as shown in the diagram. Set the nephoscope outside on a level place with the N (north) mark pointing toward the north. Look into the mirror and note a part of a cloud which appears right on the center of the cross. Follow this part of the cloud as it moves to the edge of the mirror. The direction labeled on the edge of the mirror will indicate the direction toward which the wind is moving the cloud. For example, if the nephoscope indicates that a cloud is moving toward the northeast, then the wind at that altitude is blowing from the southwest.

9
Find the derivation of the following words: meteorology, barometer, anemometer, and thermometer.

10
Report on the organization and operation of the U.S. Weather Bureau. Tell why it is necessary to have more than 2,000 weather-observing stations send information to Washington, D.C., each day.

11
Report on how your town would be affected if the Weather Bureau stopped operating today. Who would be affected and how?

Questions to guide a summary of experiences

1. What instrument is used to measure temperature? How does it operate?
2. What instrument is used to measure air pressure? How does it operate?
3. What instrument is used to measure the humidity in the atmosphere? How does it operate?
4. How is precipitation measured?
5. What two measurements of the wind are recorded by the Weather Bureau?
6. What is a "low"? A "high"?
7. What kind of weather is usually associated with "lows" and "highs"?
8. What is the general pattern of weather movement across the U.S.?
9. Of what help to the people of our country are the predictions of the Weather Bureau?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. The conditions of the atmosphere are measured by various weather instruments.
2. Atmospheric conditions vary from place to place and from time to time.
3. Low pressure areas are generally associated with poor weather and high pressure areas are generally associated with fair weather.
4. The general movement of our daily weather across the country is from west to east.
5. The Weather Bureau predicts the weather from the measured conditions of the atmosphere.
6. The weather map shows the daily conditions of our atmosphere.

VOCABULARY

anemometer	hygrometer	precipitation	thermometer
barometer	meteorologist	prediction	troposphere
circulation	nautical	rain gauge	wind vane
forecast			

SCIENTISTS

Beaufort, Francis
Celsius, Anders
Fahrenheit, Gabriel
Galilei, Galileo
Hook, Robert
Pascal, Blaise
Torricelli, Evangelista

Finding Relative Humidity in Percent

DIFFERENCE IN DEGREES BETWEEN WET-BULB AND DRY-BULB THERMOMETERS

Air Temperature (reading of dry-bulb thermometer) in degrees Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
30°	89	78	68	57	47	37	27	17	8																					
32°	90	79	69	60	50	41	31	22	13	4																				
34°	90	81	72	62	53	44	35	27	18	9	1																			
36°	91	82	73	65	56	48	39	31	23	14	6																			
38°	91	83	75	67	59	51	43	35	27	19	12	4																		
40°	92	84	76	68	61	53	46	38	31	23	16	9	2																	
42°	92	85	77	70	62	55	48	41	34	28	21	14	7																	
44°	93	85	78	71	64	57	51	44	37	31	24	18	12	5																
46°	93	86	79	72	65	59	53	46	40	34	28	22	16	10	4															
48°	93	87	80	73	67	60	54	48	42	36	31	25	19	14	8	3														
30°	93	87	81	74	68	62	56	50	44	39	33	28	22	17	12	7	2													
52°	94	88	81	75	69	63	58	52	46	41	36	30	25	20	15	10	6													
54°	94	88	82	76	70	65	59	54	48	43	38	33	28	23	18	14	9	5												
56°	94	88	82	77	71	66	61	55	50	45	40	35	31	26	21	17	12	8	4											
58°	94	89	83	77	72	67	62	57	52	47	42	38	33	28	24	20	15	11	7	3										
60°	94	89	84	78	73	68	63	58	53	49	44	40	35	31	27	22	18	14	10	6	2									
62°	94	89	84	79	74	69	64	60	55	50	46	41	37	33	29	25	21	17	13	9	6	2								
64°	95	90	85	79	75	70	66	61	56	52	48	43	39	35	31	27	23	20	16	12	9	5	2							
66°	95	90	85	80	76	71	66	62	58	53	49	45	41	37	33	29	26	22	18	15	11	8	5	1						
68°	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	31	28	24	21	17	14	11	8	4	1					
70°	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37	33	30	26	23	20	17	13	10	7	4	1				
72°	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39	35	32	28	25	22	19	16	13	10	7	4	1			
74°	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24	21	18	15	12	9	7	4	1		
76°	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42	38	35	32	29	26	23	20	17	14	12	9	6	4	1	
78°	96	91	87	83	79	75	71	67	64	60	57	53	50	46	43	40	37	34	31	28	25	22	19	16	14	11	9	6	4	1
80°	96	91	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38	35	32	29	27	24	21	18	16	13	11	8	6	4
82°	96	91	87	83	79	76	72	69	65	62	58	55	52	49	46	43	40	37	34	31	28	25	23	20	18	15	13	10	8	6
84°	96	92	88	84	80	77	73	70	66	63	59	56	53	50	47	44	41	38	35	32	30	27	25	22	20	17	15	12	10	8
86°	96	92	88	84	80	77	73	70	66	63	60	57	54	51	48	45	42	39	37	34	31	29	26	24	21	19	17	14	12	10
88°	96	92	88	85	81	78	74	71	67	64	61	58	55	52	49	46	43	41	38	35	33	30	28	25	23	21	18	16	14	12
90°	96	92	88	85	81	78	74	71	68	64	61	58	56	53	50	47	44	42	39	37	34	32	29	27	24	22	20	18	16	14

Example:

Temperature of dry-bulb thermometer *76°*
Temperature of wet-bulb thermometer 68°
The difference is 8°

Find *76°* in the dry-bulb column and 8° in the difference column. Where these two columns meet, you read the relative humidity. In this case, it is 67 percent.

Sixth Grade

d THE EARTH AND ITS COMPOSITION

MINERALS

PURPOSE OF THE UNIT: ***to learn about minerals and their identification***

Note: It is desirable for the teacher of sixth grade children to understand the difference between the words mineral *and* rock. *Minerals are natural substances of definite chemical makeup from which rocks are made. The properties of a particular mineral do not change with geographic location. For example: Quartz is a common mineral. No matter where it is found, its properties remain the same. It is harder than glass, it has a high luster (brilliance), and it is chemically composed of two parts of oxygen to one part of silicon. These characteristics are the same for* all *quartz the world over. Rocks are mixtures of minerals. Granite is a rock because it is generally composed of 3 minerals: quartz, feldspar, and mica. Granite is not always of the same composition. It is a mixture of minerals, and the mixture varies not only in what minerals are present, but also in the amounts of each mineral.*

Apparatus and materials

1. Alum
2. Belt
3. Broken brick or charcoal briquettes
4. Cardboard, heavy
5. Cobalt chloride
6. Common minerals, such as mica, talc, and halite
7. Crystals, such as pyrite, quartz, garnet, and calcite
8. Crystals, such as rock candy, rock salt, and rock quartz
9. Dilute acid
10. Dry cell, 1½ volts
11. Egg cartons or cigar boxes
12. Epsom salts
13. Ferric chloride
14. Flashlight bulb and battery
15. Food coloring
16. Hand lens
17. Household ammonia
18. Hydrochloric acid
19. Insulated wire
20. Limestone, calcite, and marble
21. Liquid, bluing
22. Lodestone
23. Machine nuts and bolts, small
24. Magnet, strong
25. Magnifying lens
26. Medicine dropper
27. Microscope slides
28. Minerals, such as salt, sulphur, mica, asbestos, and quartz
29. Ore products, such as lead, zinc, and graphite
30. Paper fasteners
31. Pie plates
32. Pocketknife
33. Rocks, such as shale, slate, granite, and dolomite
34. Sodium silicate
35. Steel file
36. Sugar, salt, or copper sulfate
37. Test tubes, Pyrex
38. Wood scraps

INTRODUCTION OF THE UNIT

Motivating activities

1
Display minerals such as salt, sulphur, mica, asbestos, and quartz.

2
Display crystals such as rock candy, rock salt, or quartz crystals.

3
Scratch a piece of glass with a piece of quartz. Place a piece of quartz and a microscope slide on a table with a card reading, " Will quartz scratch glass? Try it. Which is harder?"

4
Exhibit some common and interesting crystals such as pyrite, quartz, garnet, and calcite. Call attention to their shape.

5
Arrange a " What Is It?" display of an ore product, such as something made from lead, zinc, and graphite (lead pencil).

6
Show pictures of how various minerals are mined.

7
Using the " What Is It?" technique, display some tools and materials that are used to collect minerals.

8
Exhibit a piece of limestone and a piece of calcite. Calcite is a mineral which is found in limestone, often the only mineral found in this rock. Calcite is usually too small to be seen individually in limestone.

Motivating questions

1. What is a mineral?
2. What are minerals used for?
3. What is an ore? Do you know of any?
4. What is a mineral resource? Can mineral resources be used up?
5. What do you think is our most important mineral resource?
6. What is a geologist? A prospector?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
Coarse or fine-grained crystals. Fill a Pyrex test tube one-fourth full of alum, cover it with water, and boil gently, until the alum is completely dissolved. Suspend a weighted string in the solution and allow it to cool slowly. Repeat with another Pyrex test tube, but cool rapidly by holding the test tube in a cold-water bath. Remove the string and observe the size of crystals formed.

2
Gradually dissolve epsom salts in hot water until no more will dissolve. Brush the solution on a piece of glass and let it stand while water evaporates. Use a hand lens to examine the crystals formed.

3
The teacher may arrange an exhibit of the standard (moh's) scale of hardness. Most of the minerals on this scale are easily obtained, but topaz and diamond probably will have to be illustrated as pictures.

4
Accompany the scale of hardness exhibit with materials of known hardness which can be used to make simple tests to determine the hardness of a mineral. A fingernail (2.5) can be used to test the softer minerals. Use a copper penny (3), knife blade, or plate glass (5.5–6), and a steel file (6.5–7) as examples for testing harder minerals.

5
Demonstrate some of the other properties of minerals which may be determined with simple tests. Include the acid test using dilute hydrochloric acid, streak test, cleavage test, and fracture test. Explain that a streak plate is an easy way to find the color of a powdered mineral.

6
Start a permanent classroom mineral collection. This no doubt will grow as the unit progresses. Any collection which is not labeled is of little use as a teaching tool. Be consistent with the labeling of specimens; include such necessary information as the name, the locality, date, and collector.
Note: An amateur geologist or local museum should be able to list the minerals common to your own area.

7
Make arrangements to have a resource person talk to the class. Such a person may be the high school earth science teacher, an amateur mineral collector, the local jeweler, a geologist, or a museum representative.

Note: A variety of rock and mineral collections and specimens are commercially available from science supply houses, hobby stores, and rock shops, which may be used for some of the following activities.

Activities for children

1
Using the fingernail, a copper penny, a steel tableknife, and a small piece of glass (a microscope slide will do), have children confirm the hardness of a few common minerals. Try minerals such as quartz, feldspar, mica, calcite, talc, garnet, halite (rock salt), and pyrite. Check your results with a rock and mineral book. Group these by their hardness. Discuss cleavage as a means of identification.

2
Limestone may be identified by the fizzing action which takes place when a drop of dilute hydrochloric acid comes in contact with its surface. Make available some rocks, such as sandstone, shale, slate, granite, dolomite, and limestone. Test each with a drop of the acid from a medicine dropper. *Note: Even though dilute, care should be taken when using acid. Keep away from face and clothing.*

3
Can you tell the difference between marble and granite? Test each with a drop of hydrochloric acid. The marble will fizz because it is formed from limestone and is of the same chemical composition. Granite will show no reaction. See note following No. 2 above.

4
Calcite, a very abundant mineral, may also be identified through use of the acid test. Use the test to separate calcite from white feldspar, quartz, and other minerals. The hardness scale can also be used to identify these minerals. It is suggested that the acid be kept in an absolutely safe place after these experiences. See note following No. 2 above.

5
Many minerals have a characteristic color which is an aid to their identification. Pyrite has a brassy-yellow color and is sometimes referred to as "fools gold." Feldspar is commonly white, pink, or green. Garnet found in New York State may be dark red or pink. Calcite is usually white while magnetite is iron black. See how many other minerals you can add to this list. When you identify a mineral by color, check to see if it occurs in other colors and check some of its other properties.

6
Make a collection of varieties of quartz. Quartz is the second most abundant mineral in the earth's crust. A great many different forms of quartz exist to which variety names have been given. Each variety usually has a distinguishing characteristic, such as color or crystal form. Some of the varieties found in New York State are: rose quartz (rose-pink), milky quartz (white), smoky quartz (smoke brown or grey), rock crystal (colorless, transparent), and chert or flint (white to grey black). Other varieties which the children may be familiar with are amethyst, onyx, agate, jasper, and chalcedony.

7
Make a collection of minerals which show the effect of light on minerals. Some, like certain varieties of quartz and calcite, are transparent. The Iceland spar variety of calcite will show double refraction when placed over a pencil line or a printed word. Other minerals like mica are translucent. Light will pass through them, but the objects viewed are dim. If a mineral blocks out light, it is opaque. Some opaque minerals are pyrite, galean, and magnetite.

8
Test some minerals to note how they feel. Talc is greasy or soapy to the touch, hence the name soapstone. Graphite, the mineral from which the lead for pencils and certain lubricants are made, feels greasy. Some gem stones feel cold, while feldspar feels hard. Test other minerals and tell how they feel to your touch.

9
Make a report on the methods of discovering ore deposits and how various minerals are mined and refined. Some interesting techniques are used in mining iron, sulphur, copper, uranium, and gold.

10
Report on the uses of minerals and the products of various ores.

11
Use the diagrams at the end of this section to make solids to represent various crystal shapes.

12
Grow crystals by suspending a string into saturated solutions of alumny, sugar, salt, or copper sulfate (1 ounce to ½ pint of water). Crystals will usually require a few days for growth. Examine the results under a magnifying lens.

13
Make a crystal garden called a "poor man's garden." The ingredients needed are a pie plate, several walnut-sized pieces of broken brick or charcoal briquettes, 4 tablespoons of salt (not iodized), 4 tablespoons of liquid bluing, 4 tablespoons of water, 1 tablespoon of household ammonia, a medicine dropper, and food coloring. Mix the following materials in order — the salt, bluing, water, and ammonia. Pour this mixture over the broken brick, etc., in the dish. Spots of color may be added with the medicine dropper and food coloring. Rinse the medicine dropper between the colors. In a short time crystals will begin to form, and in a few hours will begin to form interesting shapes. The growth may continue for several days. Do not disturb the crystal garden, as it may crumble if moved. Examine the gardens with a hand lens to observe the variety of crystal shapes.

14
Grow crystals of copper sulphate, cobalt chloride, iron chloride, and others in a quart bottle solution of water glass (sodium silicate) and water. The mixture of chemicals to fill the bottle is 10 parts water to 1 part of water glass (sodium silicate). Into this solution drop some crystals of copper sulfate ($CuSO_4$), cobalt chloride ($CoCl_2$), and ferric chloride ($FeCl_3$). The crystals will begin to grow immediately, and will continue to grow for about 6 hours. The container should not be moved as the growing crystals are very fragile. Children will be intrigued with the crystal growth and the resulting shapes and patterns.

15
Test for magnetite (iron ore) in rock specimens. Obtain some rocks which are known to contain magnetite. Test this with a strong magnet. If the magnet is attracted to certain parts of the rock specimen, it contains magnetite. Examine this part with a hand lens.

16
Lodestones can be purchased from science supply houses for a nominal price. Provide a lodestone (natural magnet) for the children to examine and test its magnetic effect. Bring it close to things which are attracted to magnets. Does it act like a magnet? Place it near a compass. How does it affect the compass? Is the lodestone heavy? Compare it to other rocks of the same size.

17
Make a list of the minerals and mineral products which are found in our homes and give their uses. Some examples are: jewels, iron, gold, silver, borax, salt, copper wire, cement, plaster, and plumbing. List items in the home which are not mineral products.

Fieldwork

1
Visit a nearby museum to see the mineral collection. Notice how the minerals are grouped and the techniques used for exhibition. Many museums have gem stone exhibits with replicas of some of the more famous cut stones.

2
Visit a local jeweler to see some precious gems. Ask about their source, cutting, polishing, and uses.

3
The extent to which a directed mineral-collecting field trip would be profitable depends upon the location of the school. If such a trip could be arranged, it would be an interesting and worthwhile experience. A well-organized trip of this nature will provide an opportunity for children to become aware of the techniques and equipment which are used to collect minerals. Upon return, the specimens can be cleaned, labeled, and exhibited.

4
There are many manufacturing plants in New York State which utilize mineral ore products. It is possible to visit some of these plants. Check on those near your school.

5
Investigate the possibilities of visiting a mining operation where the ore is mined by the open-pit method.

6
Make an egg carton or cigar box rock and mineral collection. Label the specimens with pertinent information; include a key to provide an explanation to the collection.

ENRICHMENT

Questions to stimulate further thought

1. Why is gold more valuable (expensive) than iron? Which is more expensive, copper or gold? Which is more useful to man?
2. How much gold (or any other element) is dissolved in a cubic mile of sea water?
3. What are the possibilities of mining the ocean? What minerals could be found there? How will they be obtained?
4. What is a Geiger counter? How does it operate?
5. Why are gem stones valuable?
6. What are the temperature conditions in the world's deepest mines (the South African diamond mines)?

Topics for additional exploration

1
Uses of sulphur. Sulphur is used in many industrial processes such as vulcanizing rubber, refining oil, making paper, making matches, manufacturing sulphuric acid, and making drugs.

2
Talc. Talcum powder is ground-up talc (soapstone), one of the softest minerals.

3
Asbestos. Asbestos is a mineral which is fibrous and can be woven into fireproof materials, such as cloth.

4
Topographic maps. The topographic map is an indispensible tool of the professional and amateur geologist. Topographic maps of your own local area can be purchased in book and stationery stores or sporting goods shops. Sheets can be obtained which include an explanation of land forms and symbols.

5
New uses for minerals. Recent advances in industrial technology have created new uses and demands for such minerals as titanium, beryllium, columbium, and fluorite.

6
Man-made minerals. Certain minerals such as quartz and diamonds, have been produced artificially.

7
Fluorescent minerals. Fluorescent minerals emit light when placed under an ultraviolet source. The study of fluorescent materials has led to many new developments in prospecting, criminology, and chemistry.

8
Separation of minerals from ores. Minerals may be separated from their ores by various processes depending upon their concentration, chemical composition, and properties.

9
Crystals. Minerals may occur as beautifully formed crystals. The shape of a crystal is an aid to its identification.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Children may bring in samples of local rocks and minerals. Identify, label, and describe the method of formation of each.

2
Many children of this age have developed their own mineral collections. They may exhibit their collection for the class, describe where and how they collected their specimens, and how they prepared them for exhibit.

3
Construct a model mine of wood, plaster of paris, styrofoam, wire, tin cans, etc. Describe the type of mining operation on a museum-type card.

4
Set up an exhibit of economic minerals of New York State. Include a map showing the locations of mineral deposits. Display mineral specimens and some examples of products manufactured from them.

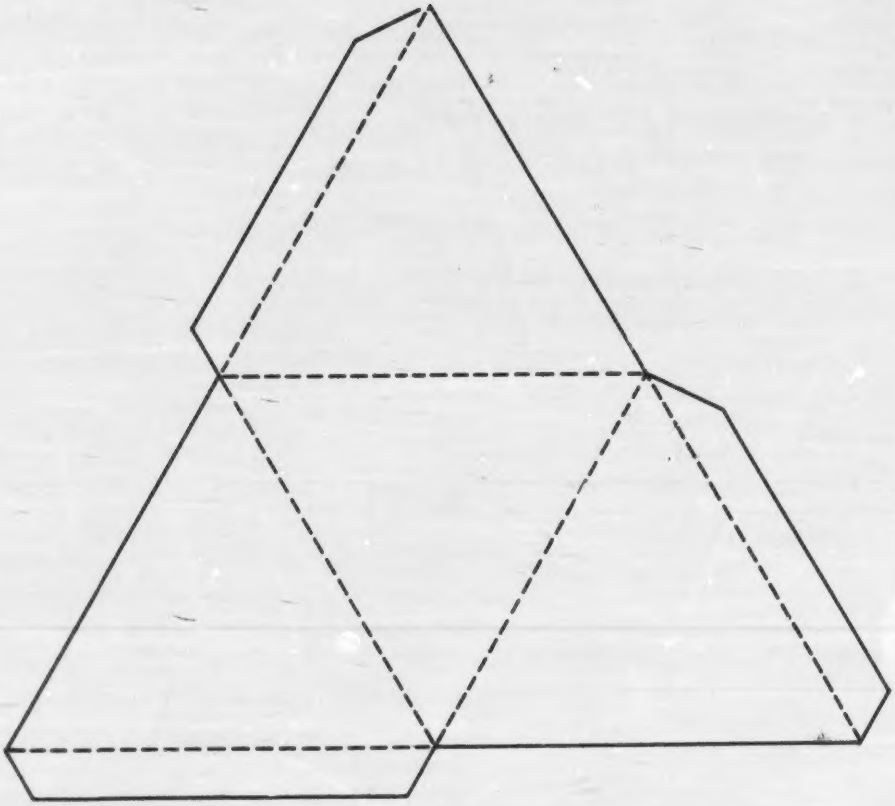
Questions to guide a summary of experiences

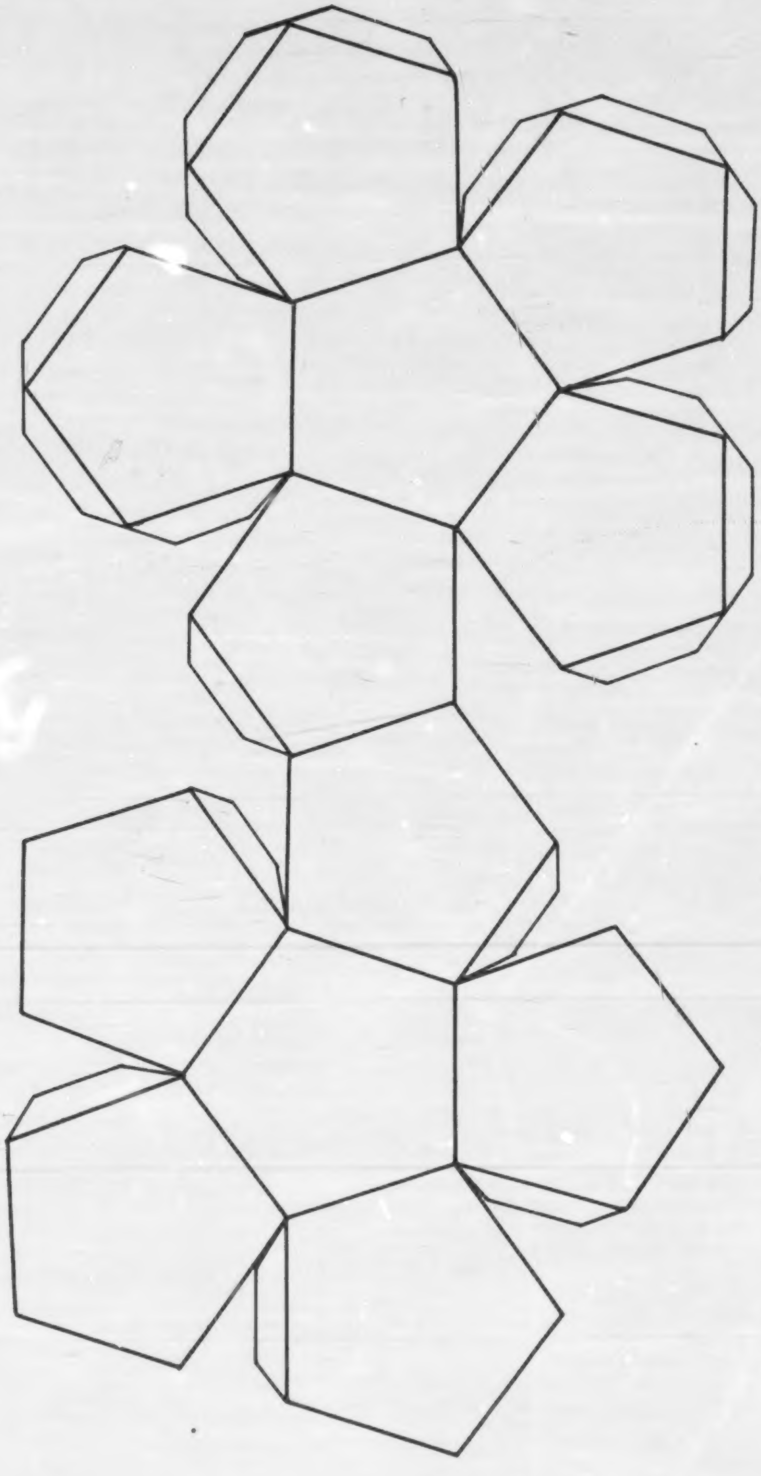
1. Of what are rocks composed?
2. What are minerals?
3. What are some properties of minerals?
4. How are minerals identified?
5. What is an ore?
6. How are minerals tested for hardness?
7. What is meant by luster? cleavage?
8. What are nonrenewable resources?
9. What conservation practices may be applied to mineral resources?

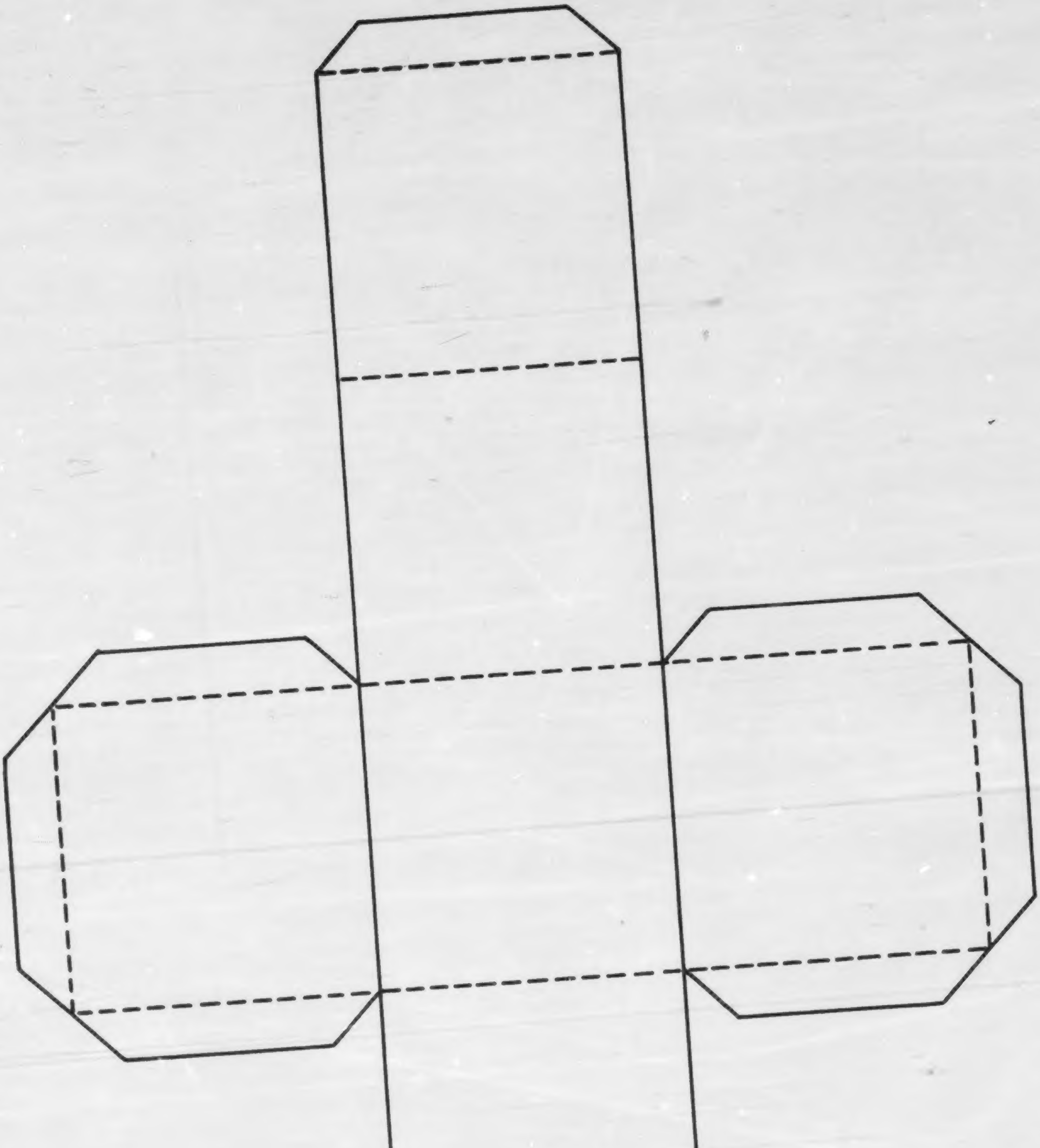
BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

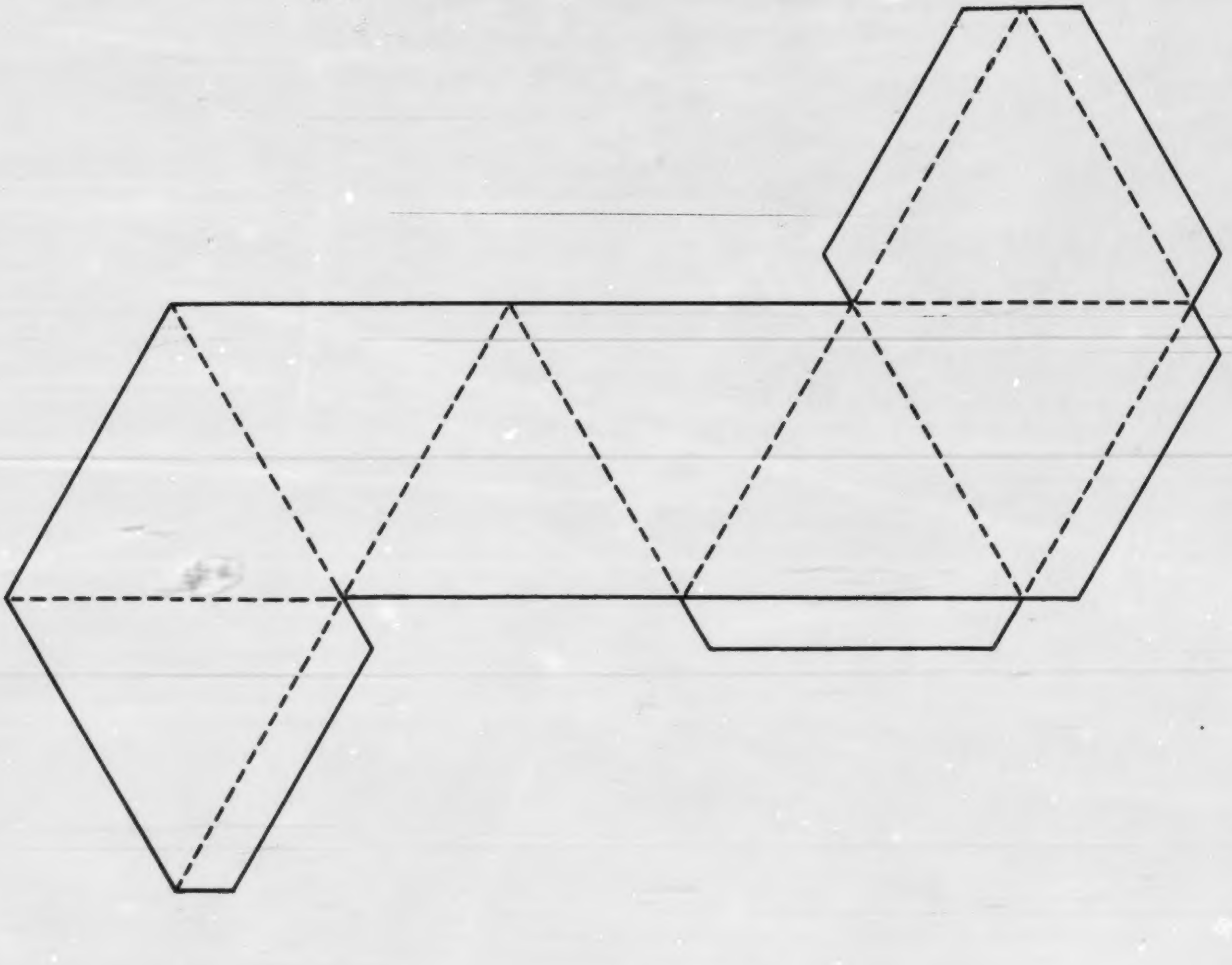
1. Rocks are mixtures of minerals.
2. Minerals are naturally occurring inorganic substances and have a definite chemical composition.
3. Minerals have definite physical properties.
4. Minerals may be identified by color, hardness, and other characteristics.
5. Minerals that can be mined profitably are usually called ores.
6. Minerals are nonrenewable resources and should be used wisely.

Many minerals are formed as natural crystals and can often be identified by their characteristic forms. The following patterns can be traced on construction paper, cut out, and folded into model crystals. Many other shapes are possible.









VOCABULARY

- asbestos
- calcite
- cleavage
- crystal
- effervescence
- feldspar
- fluorescence
- garnet
- gem
- hardness
- inorganic
- luster
- magnetite
- metallic
- mica
- mineral
- nonmetallic
- nonrenewable
- physical properties
- precious
- prospect
- quartz
- rock
- sulphur
- synthetic
- topographic maps
- ultraviolet

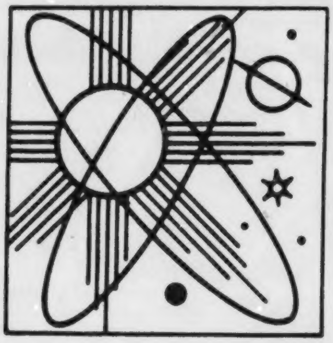
SCIENTISTS

Agassiz, Alexander
Agassiz, Louis
Emmons, Ebenezer
Hall, James
Hutton, James
Lyell, Sir Charles

Sixth Grade

e THE SOLAR SYSTEM AND BEYOND

THE UNIVERSE AND OUR KNOWLEDGE OF IT



PURPOSE OF THE UNIT: ***to learn about the nature of the universe and how we obtain knowledge about it***

Apparatus and Materials

1. Binoculars
2. Checkers
3. Cylindrical cardboard containers
4. Filmstrip projector
5. Globe
6. Liquid cement
7. Masking tape
8. Radiometer
9. Rubber stopper
10. Scrap lenses
11. Shotput or a No. 2 can
12. String
13. Strong wire
14. Telescope
15. Tennis ball
16. Transparent celestial ball
17. Volleyball
18. Water glass

INTRODUCTION OF THE UNIT

Motivating activities

1
Obtain a telescope from the high school earth science teacher or other source for display in the room. Set it up so children can look out the window at a distant object.

2
Display models or pictures of instruments which may be used for astronomical study.

3
Display photographs of the planets that have been taken through telescopes.

4
Display pictures of astronauts and the vehicles which have carried them through space. Include pictures of space vehicles of the future.

5
Find out if any children have traveled west for any distance beyond our State. Discuss the change in time from one place to another.

Motivating questions

1. Are great distances in space measured in miles? Why?
2. How did primitive people count time?
3. How do we count time?
4. What is leap year? When does it occur? Why?
5. What is an eclipse? What causes an eclipse?
6. What instruments are used to gather information about space? Are new instruments being developed?
7. In what ways do the planets differ from each other?
8. What types of energy does the sun radiate?
9. What major problems face man in the study of space?
10. What is a telescope?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1
Discuss measurements across the expanse of space. The moon, sun, and planets, though at great distances, may be measured in thousands or millions of miles. However, the stars are so far away that they are measured in light years (a measurement of distance, not time). The speed of light has been measured and has been found to be approximately 186,000 miles per second. The distance light travels in a minute would, therefore, be 186,000 times 60. The teacher can help pupils gain some appreciation of what is meant by a light year by asking them to compute the distance, in miles, that light will travel in a year.

2
To demonstrate the phases of the moon, group the children in the center of the room. A filmstrip projector representing the sun is placed several feet away at one end of the room facing the children who represent observers on earth. Elevate the projector so it is at the eye level of the teacher. The moon may be represented by a volleyball held in the beam of light. Now walk slowly about the group in a counterclockwise direction, keeping the ball in the beam. (A pupil will have to aim the beam of light from the projector so the ball remains in the beam of light.) As the teacher circles about the group, the children will

see varying portions of the illuminated surface. Move the ball around the group a second time but stop at each eighth of the "orbit" and discuss the shape of the lighted portion of the moon. At the starting point, with the ball between the children and the projector, the "moon" will be in its new phase; that is, the darkened side toward the earth. One eighth of its "orbit" later, the moon would be seen as a crescent, etc.

3
Eclipses can be demonstrated using a globe for the earth, a filmstrip projector for the sun, and a small ball suspended by a string for the moon. The children will note that when the "moon" is placed between the "sun" and the "earth" the moon casts a shadow on the earth. Because of the great distance of the shadow (approximately 240,000 miles), a total eclipse of the sun (solar) casts a very narrow shadow on the earth. When the "moon" is placed in the earth's shadow, the children will observe a "lunar eclipse."

4
Invite a local amateur astronomer to talk to the class about his hobby. Many such astronomers have constructed their own telescopes and will demonstrate them to the class.

5
Set a radiometer in the direct sunlight, or, if this is not possible, the light from a slide projector will do. Observe the vanes rotate when the radiant energy (light and heat) falls on them. Since it requires energy to turn the wheel, the incoming radiation must be carrying energy.

Note: Sunlight does not *simply push the vanes around as water pushes a paddle wheel. The motion is the result of molecular bombardment of the vanes. Refer to a high school physics text for a detailed explanation.*

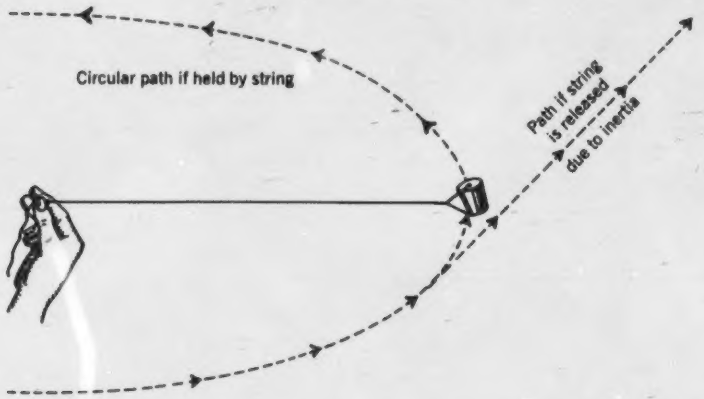
6
Inertia is the property of all matter and is a concept which should be explained before studying the motions of planets, satellites, or rockets. Simply stated, inertia is the property of matter which makes any object resist a change in motion. Objects which are not in motion tend to remain at rest. Objects which are moving tend to continue to move in the same direction. Have the children list the ways they may have experienced this phenomenon such as trying to stop very suddenly after running or hitting the dashboard in a car when it stops suddenly. Explain each example in terms of inertia.

There are a number of demonstrations which will show the property of inertia, such as those listed below. Be sure the class can explain why or how these demonstrations operate. Have the children use the term "inertia" when explaining or describing their observations.

a. Pull a piece of paper from underneath a glass of water with a sudden pull. Note that the glass does not move. After this demonstration has been explained, drag the glass along by slowly pulling the paper. Why is the result different? What is the relationship between friction and inertia in each case?

b. Make a stack of 5 or 6 checkers, and knock the bottom one out by striking it sharply with a ruler. Repeat until you are down to the last checker. Explain observations in terms of inertia and friction.

7
To explain how inertia and gravity together result in producing the orbital path of planets, the children will have to be familiar with both concepts. Review the definitions of gravity and inertia with the children. Then tie a 4-foot length of string to a one-hole rubber stopper and whirl it about in a circle, as illustrated. Have the children offer explanations as to why the stopper follows a circular path. By releasing the string (with proper safety precautions), it can be demonstrated that the inertia of the stopper tends to make it travel in a line *tangent to* its circular orbit, as indicated by the arrows in the illustration. The stopper does *not* fly out along the radius of the circle as is commonly supposed. The string represents the attraction of gravity between the planet and the sun. This attractive force keeps pulling the planet back toward the sun just enough to overcome the planets' inertia. For further explanation relating to this topic, see Fourth Grade, " The Solar System and Beyond."


Circular path if held by string
Path if string is released due to inertia

Activities for children

1
Obtain a transparent celestial globe and note the apparent path of the sun (the ecliptic) on the globe. Locate the celestial poles, the celestial equator, and find the positions of some of the prominent constellations.

2
Intermediate grade children often talk about time zones with little understanding as to the reasons for such zones. The following activity can be demonstrated by the children and should help establish an understanding that all places cannot experience the same time of day simultaneously. Place a tack or piece of masking tape on a globe to show the location of the school or town. Darken the room and shine the beam from a filmstrip projector on the globe directly at the place where the pin or tape has been located. This will represent noontime at that place. Will it also be noontime in California? England? Rotate the globe slowly in a counterclockwise direction until New York State is on the opposite side of the beam of light. What time would it be in New York now? Where is it until the tack or tape just begins to move into the light? This position represents sunrise for the marker. Has the sun already risen in England? Rotate the globe until the tape is in sunset position. Where will the sun be rising? Why is it that different places use different times?

3
Draw a large map of the United States. Locate the four standard time belts on the map. An earth science textbook can be used as a source of reference. As you mark the boundaries of the time zones on the map, you will note that they are irregular. Have the children try to explain the reason for these irregularities. Place a clock in front of each standard time zone and set it for the standard time at that particular zone. You will notice that as you proceed west, the time reads 1 hour less than the previous zone. Have the children explain why this happens. (Refer to the preceding activity.)

4
An almanac is a valuable and essential tool for the amateur astronomer. Ask pupils to find out from an almanac which morning and evening stars are visible at the time and encourage them to try to locate these planets. When either Jupiter or Venus is the morning or evening star, identification is fairly simple because they are so much brighter than the background stars.

5
Interesting individual reports can be made concerning such topics as how the planets got their names, the geography of the surface of the moon (selenography), the origin of the planetoids, the composition of comets, and the biographies of the astronomers listed at the end of this unit.

6
Review the new astronomical terms learned so far; write each one on a card, together with a simple definition of each term. Arrange the cards in alphabetical order and put them in a convenient place where they will be available for reference. A committee of three or more pupils might volunteer to take responsibility for keeping the card file up to date. The file should grow as new understandings develop and culminate in a very useful glossary.

Fieldwork

1
Conduct star gazing sessions throughout the year when the various planets are visible. Note their color, brightness, satellites (of Jupiter), and position among the stars. Optical aids, such as a telescope or good quality field glasses, are necessary to view Jupiter's satellites or the surface features of the moon. Star maps or charts will help locate prominent constellations and stars for the time of year. When observing the moon, discuss why we can see the surface so clearly. Point out that the moon does not have enough gravity to hold an atmosphere. In class, discuss some of the consequences of both the absence of air and the weak gravity of the moon.

Note: If an opportunity arises so the school can buy a telescope, before making any purchase, be absolutely sure to get advice from a competent person. A poor quality telescope, no matter what its magnification, is a useless piece of equipment. Do not buy a " high powered " telescope at a bargain price. If no expert is available to give advice, insist on viewing the moon through the instrument before making the purchase. If the instrument is subject to vibrations, unstable and awkward, or produces a fuzzy image, it will not be satisfactory for pupil use.

2
Many cities have planetariums where stars are projected on a domed ceiling. A visit to a planetarium is a valuable experience and should be attempted if at all possible. The facilities of the planetarium make it possible to demonstrate, in a very short time, many of the phenomena which occur in the universe. A person trained in astronomy will help the children orient themselves to the visible constellations, locate the visible planets for the time of the year, demonstrate the apparent motions of the stars, and provide interesting facts.

3
If there is a college nearby which has an observatory or a large telescope, it may be possible to arrange a trip to see it. Perhaps small groups may be allowed to look through the instrument early some evening. Usually arrangements can be made so the visit will not interfere with the professional program of the observatory and a staff member can talk to the children and explain the observatory's program.

ENRICHMENT

Questions to stimulate further thought

1. Do you think it is possible to harness the energy of tides for the production of hydroelectric power?
2. When will solar eclipses occur during the next 10 years?
3. The earth's atmosphere interferes with astronomical observations. What are some ways of overcoming this obstacle for better observation of the planets in our solar system?
4. What is radio astronomy? Where is the largest radio telescope in the world?
5. How do astronomers know what the sun is made of?
6. Even if there is intelligent life in other solar systems, what is the main problem involved in interstellar communication? Can this ever be overcome?
7. What is the origin of the word "month?" "Telescope?" "Helium?"
8. Why do comets' tails always point away from the sun?
9. Is the moon really larger (as it appears to be) when it appears near the horizon? How can this be checked?
10. How did man originally define units of time, such as year, month, season, and day.

Topics for additional exploration

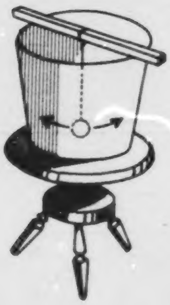
1
Selenography. Selenography is the study of the surface of the moon. Astronomers have been able to map the moon's visible surface in great detail, and have produced numerous maps which show lunar surface features and locations.

2
Time belts. The time belts of the United States average about 15° longitude in width. There is a difference of 1 hour between each 15° of longitude. This figure was arrived at by dividing 360 by 24 hours. Knowing this, can you compute the time for London, England, or Berlin, Germany, based on local standard time?

3
The ecliptic. The apparent path of the sun across the sky is called the ecliptic.

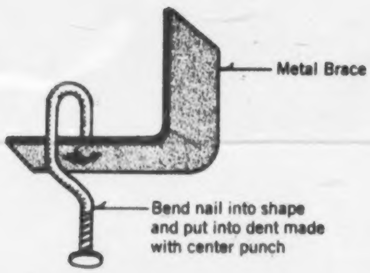
4
Perihelion and aphelion. During a planet's orbit about the sun it is closest to the sun at one point during its year and furthest from the sun at another point. The point when it is nearest to the sun is called perihelion, and when it is farthest, it is at aphelion. The planet earth is at aphelion during the winter months and at perihelion during the summer in the northern hemisphere. Why are we warmer in summer?

5
Telescope lens systems. When you view terrestrial objects through an astronomical telescope, they appear upside down. To use such a telescope for viewing objects on earth, another lens would have to be inserted in the system so the image would appear erect. The astronomer does not want another lens in his viewing instrument because every lens absorbs a little light, thus reducing the effectiveness of the telescope.



6

a. *The earth's rotation.* A convincing demonstration which shows that the earth rotates is provided by the Foucault pendulum. To be clear to the children, the demonstration should be shown in two parts. First, place an empty wastebasket on top of a stool with a seat that rotates such as a piano stool. Tie a string to a heavy weight and fasten the other end of the string to a stick long enough to fit across the top of the basket as illustrated. Start the weight swinging, then rotate the wastebasket on the stool seat. The direction of the path of the swinging weight does not change as the basket turns.


Metal Brace
Bend nail into shape and put into dent made with center punch

b. Foucault's classic experiment can now be demonstrated. Borrow a 12-pound shot from the physical education teacher for the pendulum or you may use a No. 2 can filled with sand. Hang the can, or the shot wrapped in heavy cloth, from the highest place in the room (in some schools you may have to use the cafeteria or gymnasium) with a length of strong wire. The suspension itself must be nearly frictionless. One such mount can be made as shown in the diagram.

Bring the pendulum (shot) about 3 feet back to one side and tie it to a solid object with string. When the pendulum is motionless, burn the string in two and the pendulum will start to swing back and forth. (If the pendulum is released by hand, it is apt to have a twisting motion.) Being careful not to touch the swinging pendulum, mark its path on the floor with chalk. After 10 minutes, note that the path of the pendulum is no longer over the chalk lines. It will be crossing the line and will seem to be deviating toward the right. The floor under it is actually turning toward the left. Better results will be obtained if the pendulum wire is over 10 feet long.

7
The conversion of solar radiation into mechanical energy. Discover why a radiometer rotates when sunlight falls on it. A high school physics text or a visit to a physics teacher would be a good reference.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Construct a model of the Galilean telescope from scrap lenses. Chipped lenses may be purchased at a nominal price from some supply houses. These work very well and sometimes directions for making these small telescopes are included. Small mailing tubes or other cylindrical cardboard containers may be utilized as tubes to house the lens system. The lenses may be held in place with liquid cement or masking tape wound around the lens.

2
Diagrams showing the path of light through telescopes may be drawn to supplement the models constructed. Show how light from an object enters the telescope and how it appears to someone looking through the telescope.

3
Find pictures of early timekeeping devices. Show what kind of time they measured (hours, days, months) and discuss their method of operation.

4
Using information found in encyclopedias and other reference books, construct some models of early timekeeping devices, such as water clocks, and sundials.

5
Make booklets for individual planets, with pictures, date of discovery, pertinent information, symbols, and myths.

6
Keep scrapbooks regarding astronomical observations, recent discoveries, new instruments, and other current happenings.

7
Report on the purpose and activities of the I.G.Y.

8
Collect information about United States space probes.

9
Craters, dark areas, and mountain ranges may be seen in some large illustrations and maps of the moon. These have been given names by astronomers. Find the names of some of the prominent or interesting features.

10
Models of rockets, satellites, and space vehicles may be constructed from cartons, cans, styrofoam, wire, wood, plastic, and other materials.

11
Constellations may be outlined on old lampshades by punching holes in the shade with a darning needle. Check a star chart for the correct positioning of the stars. When the shade is placed over a lamp in a darkened room, the stars that form the constellations will be visible on the lampshade.

12
If the school does not have a planetarium, a simple one may be made from an old black umbrella. Open the umbrella and, with a piece of white chalk or powder paint, draw the principal northern circumpolar constellations on the inside. Check circumpolar star charts for the approximate positions of these stars. Hold the umbrella overhead pointing north, and turn the umbrella slowly to note the apparent movement of the circumpolar stars about the celestial pole (North Star). You may wish to devise a support for this model.

13
Models can be constructed to help children become familiar with the major constellations. These are made from plastic clay or small styrofoam balls connected with cotton swab sticks. Use star maps as a guide to make models of the Big Dipper, Cassiopeia, Little Dipper, Orion, Draco, and others. The stars in the model constellations can be positioned more accurately if diagrams are first drawn on paper, then assembled from this plan. The finished products can be used for a bulletin board display.

Questions to guide a summary of experiences

1. What is gravity? Inertia? Friction?
2. How do the planets differ from one another?
3. What is solar radiation? How is it useful to living things?
4. How does the solar eclipse occur?
5. How does a lunar eclipse occur?
6. What are the tools of astronomers?
7. What is a light year? Why is such a unit used?
8. What is the basis for our units of time on earth?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Planets differ in physical characteristics such as size, motion, gravity, atmosphere, and temperature.
2. Forces man must consider when sending rockets into space are gravity, inertia, and friction.
3. Energy released from the sun is called solar radiation.
4. When the moon blocks the sunlight from the earth, a solar eclipse occurs.
5. When the earth blocks the sunlight from the moon, a lunar eclipse occurs.
6. The phases of the moon result from our viewing various amounts of the lighted side of the moon.
7. Our units of time are based on astronomical motions.

8. Astronomers use telescopes, spectroscopes, and cameras in their observations.
9. The great distances through space are often measured in light years.
10. Our knowledge of astronomy has developed as the result of the work of many scientists over many years. This knowledge is incomplete, and always subject to questioning and change.

VOCABULARY

annular
astronauts
eclipse
friction
inertia
lunar
meridian
observatories
partial
radiation
solar
spectroscopes
superstitions
time zones
vehicle

SCIENTISTS

Galilei, Galileo
Gamow, George
Goddard, Robert
Halley, Edmund
Herschel, (Family)
Keplar, Johannes
Newton, Sir Isaac
Oberth, Hermann
Van Allen, James

Sixth Grade

f MATTER AND ENERGY

THE NATURE OF MATTER

PURPOSE OF THE UNIT: ***to gain an understanding of the nature of matter, its basic structure and its properties***

Apparatus and Materials

1. Alcohol
2. Ammonia, small bottle
3. Baking soda
4. Beaker, small Pyrex
5. Bell wire
6. Bottle, glass with screw cap
7. Bunsen burner
8. Candles, several
9. Cardboard
10. Copper sulfate or alum
11. Dish, shallow
12. Ether, small bottle
13. Evaporating dish
14. Glass tubing
15. Ink
16. Jars, half pint, pint, quart, and gallon
17. Jar, large beaker or battery jar
18. Mercuric oxide
19. Nails
20. Perfume, small bottle
21. Salt
22. Sawdust
23. Silver nitrate solution (borrow from chemistry department)
24. Sugar
25. Sulfuric acid
26. Test tube holder
27. Test tubes, Pyrex
28. Vinegar

INTRODUCTION OF THE UNIT

Motivating activities

1

Make a bulletin board display showing diagrams of atoms and molecules. Photographs of accelerators, nuclear powered ships, and electrical generators should also be included.

2

Display pictures of objects which are all made of the same element. Include a sign that asks: "What have all these things in common?" For example: aluminum, electrical high-tension transmission wires, frying pan, aluminum siding on a house, storm door, aluminum ships, deck chairs, coffee pot, and other items.

Motivating questions

1. What is matter?
2. What are elements?
3. What are atoms?
4. What are atoms made of?
5. What does H_2O mean? Why do scientists write this way?

EXPERIENCES RELATING TO THE UNIT

Teacher-directed activities

1

Through general class discussion, bring out and develop the following concepts:

a. Our universe is composed of matter and energy.
b. Energy is what causes matter to change or move.
c. Matter is anything which takes up space or has weight (mass).
d. All matter with which we are familiar is composed of one or more elements.
e. There are over 100 known elements.
f. Some matter is composed of a single element. Some matter, referred to as compound, is made of more than one element.

2

Scientists have accepted certain abbreviations for the elements which save time and make scientific reports easier to read. Below are listed some of the better-known elements and the symbol for each.

Aluminum	– Al	Fluorine	– Fl	Nickel	– Ni	Sodium	– Na
Calcium	– Ca	Hydrogen	– H	Nitrogen	– N	Sulfur	– S
Carbon	– C	Iodine	– I	Oxygen	– O	Uranium	– U
Chlorine	– Cl	Iron	– Fe	Phosphorus	– P	Zinc	– Zn
Copper	– Cu						

3
Most of the substances we are familiar with are compounds, that is, they are composed of two or more different kinds of atoms (elements). If we could divide a compound into smaller and smaller pieces we would finally have a single molecule. A molecule is the smallest bit of a compound that has the properties of the compound. For example, water is a compound composed of two parts hydrogen and one part oxygen. The scientist refers to a molecule of water as H_2O. H stands for hydrogen, O stands for oxygen and the subscript 2 means that it requires two atoms of hydrogen plus one atom of oxygen to form a single water molecule. Use the following list of examples and have the pupils determine what kinds of atoms, and how many of each, form the molecules of these common substances.

Water	— H_2O	(A molecule of water is composed of two atoms hydrogen and one oxygen atom.)
Salt	— NaCl	(A molecule of salt is composed of one atom of sodium and one atom of chlorine.)
Household ammonia	— NH_4OH	(A molecule of ammonia is composed of one atom of nitrogen, one atom of oxygen, and five atoms of hydrogen.)
Baking soda	— $NaHCO_3$	
Carbon dioxide	— CO_2	
Carbon monoxide	— CO	
Ferric oxide (rust)	— Fe_2O_3	
Hydrochloric acid	— HCl	
Hydrogen peroxide	— H_2O_2	
Sugar	— $C_6H_{12}O_6$	
Starch	— $C_6H_{10}O_5$	
Carbon tetrachloride (cleaning fluid)	— CCl_4	
Nitric acid	— HNO_3	
Sulfuric acid	— H_2SO_4	

4
To show some evidence that matter is composed of tiny invisible particles, the following demonstrations can be used:

a. Pour some ether, ammonia, or perfume in a shallow dish. Ask pupils to indicate when they first notice the odor as it diffuses through the air in the room. Invite pupils to suggest an explanation for the spread of the fumes across the room. A reasonable assumption is that a little of the liquid evaporates and escapes into the air. This idea can easily be tested by exposing a small quantity of a liquid to air until it disappears. It may then be pointed out that the liquid must have been made up of tiny invisible particles, and that the tiny invisible particles must be in motion. Smear some ether, alcohol, and water on the chalkboard; invite explanations for the different rates of disappearance. Discuss clothes drying, etc., and if time permits, humidity.

Fill a large beaker or battery jar with water. Next dip a piece of glass tubing into a bottle of ink. Place the finger on top of the tube and remove it from the bottle so that a column of ink, 2 or 3 inches in length, remains in the lower end of the tube. Wipe off the outside of the tube and, with the finger still in place, lower the tube carefully into the vessel of water. When the top of the column of ink inside the tube is level with the water surface, remove the finger for a moment and allow a few drops to flow downward without mixing with water. Replace the finger on the tube and remove the tube carefully. The few drops of ink should now be suspended near the center of the vessel of water. Watch the vessel and notice the gradual diffusion of the ink through the water. Note the time required for the color to be uniformly distributed throughout the vessel.

5

Chemistry is the study of the composition of materials, that is, how atoms join together to form molecules or how molecules can break down into simpler substances. The process of producing new substances is referred to as chemical change. A few demonstrations which show chemical change follow. Point out that, in all cases, a new substance is produced.

a. Demonstrate the decomposition of mercuric oxide by heating. Put about ½ teaspoonful of mercuric oxide in a Pyrex test tube and heat with a Bunsen burner. Use a test tube holder and clamp it next to the mouth of the tube. Call attention to the little drops of mercury that form on the sides of the tube. Test the gas produced with a glowing splint to show that it is oxygen.

b. Demonstrate the formation of a precipitate. A few drops of silver nitrate solution added to clear saltwater will produce a thick white precipitate of silver chloride. Other examples of precipitates that make dramatic demonstrations are the addition of ammonia to copper sulfate or alum.

TEACHER DEMONSTRATION ONLY!!

c. A dramatic chemical change takes place when concentrated sulfuric acid is poured on a few tablespoonfuls of sugar in the bottom of a small beaker. The acid removes water from the sugar and leaves carbon which swells to an enormous volume because of the gas bubbles. Note that heat is released as a result of the reaction. For this reason, use a Pyrex beaker. Concentrated sulfuric acid is a most dangerous chemical. The teacher should handle it with extreme caution and the bottle should be returned to the chemistry teacher after use. *Under no circumstances should children have access to any concentrated acid.*

6

Physical changes, as distinct from chemical changes, are changes in shape or form rather than changes in chemical composition. Tearing a sheet of paper in half is an example of a physical change; the paper is changed, but it is still paper. Have the pupils classify a number of changes as either physical or chemical. Encourage discussion as to why the children make the choices they do.
Include such examples as:

Painting a block
Burning a stick
Sawing a board
Smashing a raw egg
Baking a cake
Exploding dynamite
Rotting wood
Rusting iron
Melting ice
Dissolving salt in water, etc.

7

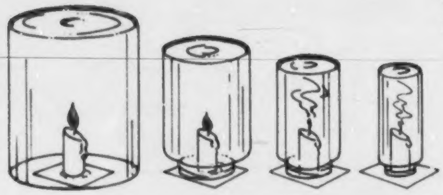
Develop the understanding that change of state (solid to liquid to gas, etc.) is a physical change. A cube of ice (H_2O) is so cold that its molecules cannot move about freely. Liquid water (H_2O) is warm enough to allow the individual molecules to slide past each other. The molecules of water pour out of a jar much as grains of sand can pour out of a jar. When heated sufficiently, the molecules move completely free of each other and move off in independent directions as steam (H_2O). Allow an ice cube to melt, boil the resulting water in a test tube, and allow the escaping steam to hit a cool glass plate in order to condense back into the liquid state.

a. Attach cardboard bases to several candles so that they will stand upright. To do this, cut new or used candles into pieces 2 or 3 inches long and chip off one end of each so that the wick projects about a quarter of an inch. Ignite a candle and hold it sideways so that melted wax drops off. Drip three or four drops on the center of several filing cards or pieces of cardboard. Hold the short candles against these until the wax hardens.

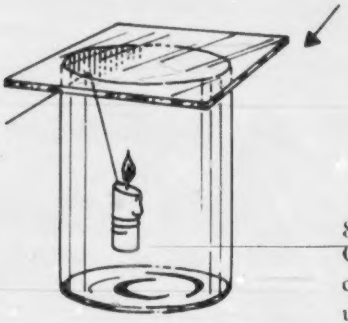
Invert a glass jar over a burning candle held upright by the cardboard candleholder. When the flame disappears, ask for conclusions. Accept no conclusions that are not justified by the evidence. Now ask the class to propose conclusions which they can really justify. After several have been suggested, accept the conclusion that a candle will not continue to burn in a small closed space.

It is difficult to prove, without elaborate equipment, that oxygen is necessary for burning. There are a wealth of activities, however, which show the need for a continuous supply of fresh air to maintain combustion. Carefully drawn conclusions and limited generalizations can result from these activities, which will encourage the scientific attitude and help develop habits of critical thinking. After a suitable background has been established, the role of oxygen in burning can be explained.

b. Direct four pupils to invert, at a given signal, four glass jars over four burning candles. Halfpint, pint, quart, and gallon jars or some similar gradation of sizes may be used. Use care in drawing conclusions from the observations made.



c. Wrap one end of a piece of soft wire, such as bell wire, around a candle and bend the other end to serve as a handle. Light the candle and lower it into a wide-mouthed gallon jar. Cover the jar with a glass plate. When the flame is extinguished, withdraw the candle, ignite it, and lower the candle into the jar again. When the flame goes out again, remove the plate and candle, fill the jar with water, and empty it to change the air. Then repeat the experiment once more. Note the time required for the flame to be extinguished in each case. What could be the reason for such observations?



8

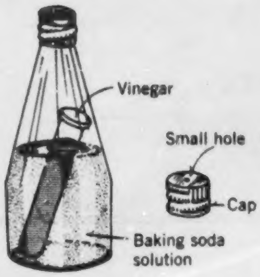
Combustion, or burning, is an example of chemical change. It is interesting to children, can be related to both useful and destructive situations, and, through understanding of its processes, safety measures can be appreciated.

A common approach to the study of fire is the demonstration in which a glass jar is inverted over a lighted candle. When the candle goes out, we are likely to conclude that fire needs oxygen to burn. Actually such a conclusion is not at all justified, because the experiment does not show that lack of oxygen caused the fire to go out, or even that there was less oxygen in the jar after the candle was extinguished than there was in the beginning. About all that we may safely conclude from this experiment is that a candle will not continue to burn in a closed space.

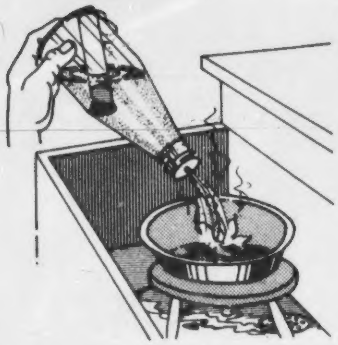
a. Have children study a lighted candle. Point out that both physical and chemical changes are occurring. Solid paraffin is melted from the heat of the flame and flows up the wick into a hotter area, where it is vaporized and finally burns. If the class has previously carried out activity No. 2 above, they may appreciate a discussion of the chemistry of the burning fuel. Candle wax is composed of carbon (C) plus hydrogen (H) and oxygen (O). When burning takes place, these elements are rearranged into new substances, namely, carbon dioxide (CO_2) and water (H_2O). Both of these products are in the gaseous state and therefore not directly visible.

b. Wood also must be hot enough to vaporize before it burns. Put some sawdust into a Pyrex test tube. Connect this to a nozzle. Heat the sawdust and ignite the gas that issues from the nozzle.

9
Fires may be extinguished by one of three methods: (1) By removing the supply of fuel, e.g., turning off a gas jet; (2) by keeping out oxygen (or air), e.g., throwing a blanket over a small fire or covering a candle with a jar; (3) by cooling, e.g., pouring water on a fire. After the concept of activity No. 8 above has been developed, point out that the process of pouring water on a fire cools the fuel so that it can no longer vaporize. Many children will probably believe that water smothers the fire.



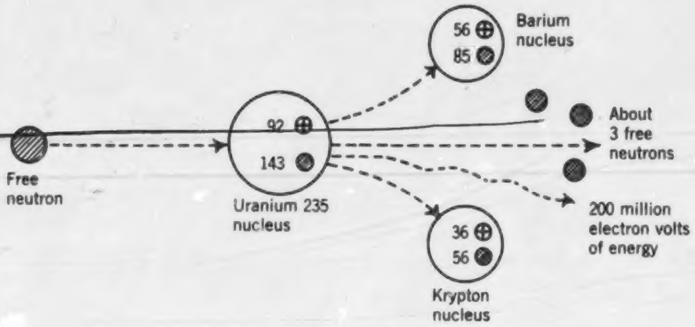
10
Make a soda-acid fire extinguisher model. Obtain a glass bottle that has a screw cap. The type commonly used for salad dressing is suitable. Punch a small hole through the center of the metal cap with the aid of a finishing nail. Partially fill the bottle with a solution containing two or three teaspoonfuls of baking soda. Nearly fill a test tube with vinegar (a mild acid), and carefully place it in the bottle as shown in the diagram. Screw the cap on tightly.



To operate the extinguisher merely invert the bottle and direct the stream onto a small heap of paper burning in the sink. Discuss the purpose of the acid and the baking soda. Point out that the water is the principal fire-extinguisher agent, but that carbon dioxide aids in the process. Exhibit a commercial soda-acid extinguisher and discuss its advantages and disadvantages.

11
Radioactivity, although a relatively complex phenomenon, is becoming such an increasingly important part of our culture that it should be included in the study of matter and energy. After the pupils have constructed a number of diagrams as suggested earlier, draw a diagram of an uranium atom on the chalkboard (atomic number 92, atomic weight 235). When 92 protons and 143 neutrons are all packed into the nucleus, the nucleus can be compared to a balloon which is blown up to maximum value. If an additional particle is then pushed into the crowded nucleus, the nucleus is unable to hold all the particles and splits apart. As the nucleus splits, energy is released. The following shows one of the possible ways a uranium atom may split.

WHEN URANIUM SPLITS



In nuclear reactors, there is a supply of radioactive material, i.e., material composed of atoms which are splitting apart, which is constantly releasing quantities of energy in the form of heat. This heat energy is then used to turn water to steam, which turns a turbine to produce electricity in the usual fashion.
Note: Although the term "atomic energy" may be in common usage, it is desirable to have the children understand why the term "nuclear energy" is much more appropriate. As explained above, it is the nucleus of the atom that splits (fissions) and releases energy. The energy had been previously [illegible] the nucleus — not generally distributed throughout the whole atom.

Activities for children

1

Diagrams of atoms may be drawn or simple models made of clay or other construction material. If a periodic table is not available, information from the following chart can be used when studying the structure of the atom.

Element	Atomic Number	Atomic Weight	Particles in Nucleus		Electron Arrangement
			Protons	Neutrons	
Hydrogen	1	1	1	0	1
Helium	2	4	2	2	2
Lithium	3	7	3	4	2,1
Beryllium	4	9	4	5	2,2
Boron	5	11	5	6	2,3
Carbon	6	12	6	6	2,4
Nitrogen	7	14	7	7	2,5
Oxygen	8	16	8	8	2,6
Fluorine	9	19	9	10	2,7
Neon	10	20	10	10	2,8
Sodium	11	23	11	12	2,8,1
Magnesium	12	24	12	12	2,8,2
Aluminum	13	27	13	14	2,8,3
Silicon	14	28	14	14	2,8,4
Phosphorus	15	31	15	16	2,8,5
Sulfur	16	32	16	16	2,8,6
Chlorine	17	35	17	18	2,8,7
Argon	18	40	18	22	2,8,8

In order to make diagrams or models of atoms, simple rules must be followed:

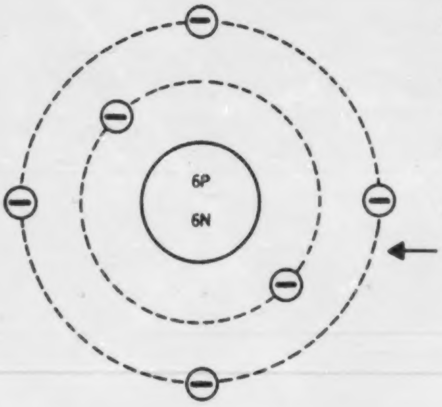
a. The nucleus or central core of the atom contains the protons and neutrons.

b. The atomic number of an atom is equal to the number of protons in its nucleus.

c. The atomic weight of an atom is the total number of particles in its nucleus (neutrons plus protons).

d. Electrons orbit the nucleus and are the same in number as the protons.

e. No more than 2 electrons can be in the first orbit. No more than 8 electrons can be in the second orbit.



Example: Diagram of an atom of carbon
Atomic number = 6
Atomic weight = 12

2

Because of the ways that molecules join together, certain substances form crystals.

Pupils may be interested in growing giant crystals from tiny seed crystals. Prepare a saturated solution of copper sulfate and filter to remove any particles. Pour a little of this into a clean evaporating dish and allow to stand undisturbed until many small crystals have formed. Select one crystal that is as perfect as possible; put it into some more of the saturated solution in another dish. This acts as a seed crystal and will become larger as more copper sulfate crystallizes. Periodically it can be put in fresh solution and, if watched carefully, can be built up into a large crystal. Copper sulfate alum and hypo will give good results. Giant crystals can be made from rochelle salts in this way.

3
Rock candy crystals can be made as follows: Add about 1¾ cups of sugar to 1 cup of boiling water, and stir until the sugar dissolves; allow the solution to cool. When cool, pour the solution into a beaker or glass and hang a piece of cotton thread or string in it. The string may be held in position by tying it to a pencil laid across the top of the beaker and weighted with a paper clip. In a few hours small crystals will form on the string; if left undisturbed for a few days, these crystals will grow large. The crystals can be handed out to the class and eaten.

Fieldwork

1
The high school chemistry laboratory will provide the pupils with an opportunity to see the tools and apparatus used by chemists.

2
Some high schools have chemistry clubs, whose members will visit the elementary grades, explain some of the rudiments of chemistry, and perform simple demonstrations.

3
The local chapter of the American Chemical Society will often provide speakers on topics which would be of interest to the pupils. Other organizations which may be able to provide guest speakers on the topic of the role chemistry plays in industry are the telephone company and the power and light company.

4
A visit to the high school home economics department could profitably follow a unit of study on the chemistry of food preparation. Why do our mothers use baking powder, baking soda, egg white, lemon juice, or salt? What results are expected?

ENRICHMENT

Questions to stimulate further thought

1. If there were only four elements in the universe, how many different kinds of materials could exist? (How many different combinations or arrangements can there be of four things?)
2. What is an isotope?
3. What is nuclear fission?
4. What is nuclear fusion?

Topics for additional exploration

1
Man-made elements. Physicists have been able to produce a few elements which are not found naturally.

2
The fourth state of matter. Under extremely high temperature conditions plasmas exist which are different from solid, liquid, or gaseous states.

3
The periodic table. The organization of the periodic table shows how elements having similar structure also have similar properties.

4
The cyclotron. Lawrence built the first particle accelerator.

5
The elements according to the early Greeks. In ancient times it was thought that all matter was made of some combination of fire, earth, air, and water.

6
Peaceful uses of nuclear energy. This relatively new area of science will affect the future life of all pupils in school today. Some interesting areas to explore are: the generation of electricity, combating disease, preserving food, propelling rockets, and tracing the movement of atoms through both machines and living things.

7
Detection of radioactivity. How do the cloud chamber, the Geiger counter, the electroscope, and the film badge detect radiation?

8
Symbols of elements. Find why the seemingly odd symbols are used for certain elements, for example, Au for gold, Pb for lead, Ag for silver.

ORGANIZATION AND USE OF INFORMATION GAINED

Projects

1
Make a list of some of the common elements and their chemical symbols. Following each element give an example of a use for it, if any uses are known.

2
Make a glossary of scientific terms relating to atoms and the structure of matter. Write each term on a separate card, with a simple definition. One of the class members may accept the responsibility for keeping the glossary alphabetized and up to date.

3
Draw concentric circles on paper pasted on heavy cardboard; use this to represent the distribution of atomic particles of the lighter atoms.

Obtain thumbtacks of three different colors to represent protons, neutrons, and electrons. Use the smallest circle on the cardboard for the nuclear particles, and larger circle for the orbits of the electrons. Use the reference table from this unit, "Activities for Children," for the needed information.

Show that each additional proton in the nucleus, plus an electron outside the nucleus, produces an atom of another element. Neutrons must be added to the nucleus to make correct atomic weights.

4
Make models of simple molecules from styrofoam.

5
Make an exhibit of the products of coal: fuel, plastics, drugs, rubber, dyes, etc.

6
Make a chart of the 10 most common elements, the relative abundance of each, and the uses man has made of them.

Questions to guide a summary of experiences

1. What is matter?
2. Of what is all matter composed?
3. How many different kinds of atoms are there?
4. What are atoms made of?
5. What are compounds?
6. How does the chemist write chemical formulas? Why has he developed this type of "shorthand"?
7. How does a chemical change differ from a physical change?
8. What are radioactive materials?
9. How does man use radioactivity to produce useful energy?

BASIC UNDERSTANDINGS TO BE GAINED FROM THIS UNIT

1. Matter is composed of very small particles called atoms.
2. Groups of atoms join together to form molecules.
3. A substance composed of only one kind of atom is called an element.
4. There are over 100 known elements.
5. Elements can combine to form compounds.
6. Chemical changes result in the formation of new substances.
7. The combustion of fuel is a chemical change which releases energy.
8. Physical changes do not result in the formation of new substances.
9. Matter may be solid, liquid, or gas, depending on the behavior of its molecules.
10. Some atoms are radioactive and release energy.
11. Man has learned to use the energy released from radioactive materials, which is called nuclear energy.

VOCABULARY

atom
chemical change
compounds
electrons
elements
energy
matter
molecules
neutrons
nuclear energy
nucleus
physical change
protons
radioactive

SCIENTISTS

Bohr, Niels
Curie, (Family)
Lavoisier, Antoine
Lawrence, Ernest
Nobel, Alfred
Priestly, Joseph

ORGANIZATION OF ELEMENTARY SCHOOL SCIENCE

	I. LIVING THINGS	II. GROWING BODIES	III. AIR, WATER, AND WEATHER
KINDER-GARTEN	1. All things are either living or nonliving. 2. Living things can be plant or animal. 3. There are many kinds of plants and animals. 4. Plants and animals need food, air, and water to live. 5. Green plants need light to grow.	1. All living things grow. 2. All living things are not the same size. 3. We cannot tell how big we will become. 4. For growth, we need certain basic things, such as water, food, light, air, and exercise.	1. Air is all around us. 2. We can feel air but we cannot see it. 3. We can see what air does. 4. Moving air is called wind. 5. Air can warm us or cool us.
GRADE 1	1. Most animals can move from place to place. 2. Animals move in different ways. 3. Animals live in many kinds of places. 4. There are many kinds of plants. 5. Most plants cannot move about as animals do. 6. Certain conditions (temperature, water, etc.) are necessary for living things.	1. Certain kinds of food are necessary for growth. 2. Some foods are better for us than others. 3. Food alone does not determine how we grow. 4. We need more of some kinds of food than others.	1. Air takes up space. 2. Most containers which we say are empty are really filled with air. 3. The surface of the earth is warmed in the daytime and cooled at night. This in turn warms or cools the air above it. 4. Winds move at different speeds and from different directions. 5. Winds can carry plant seeds. 6. Winds help things to dry. 7. Winds are sometimes harmful. 8. Rain and snow come from water vapor (clouds) in the air. 9. Clouds have different shapes.
GRADE 2	1. Some animals eat plants. 2. Some animals hunt other animals for food. 3. Green plants make their own food. 4. Green plants store food in their roots, stems, leaves, bulbs, and seeds. 5. Some animals move from place to place with the seasons in order to find food. 6. Living things change as they grow.	1. Teeth decay because of acids produced in the mouth by bacterial action on food. 2. Sweet, sticky food is more harmful to our teeth than coarse, crisp food. 3. We can protect our teeth by brushing after we eat. 4. Even with good personal care we need to have our teeth looked at regularly by the dentist.	1. Fire needs air to burn. 2. Plants and animals generally need air to live. 3. A thermometer measures temperature. 4. Temperature is a measure of "hotness." 5. A cloud is made of water droplets or tiny ice crystals. 6. Weather affects our work and play. 7. Water evaporates from puddles, lakes, and oceans to go into the air again.
GRADE 3	1. Plants and animals depend on other living things for their well-being. 2. Many plants and animals are adapted to living in certain kinds of places. 3. Many animals have special adaptations which protect them from their enemies. 4. Man depends on other living things for his food, clothing, and shelter. 5. Man should exercise good conservation practices so as not to disrupt the interdependence of living things.	1. Sleep is essential to life. 2. Rest before fatigue is considered better than rest following fatigue. 3. Sleep comes easily in the proper atmosphere. 4. Lack of sleep affects us emotionally as well as physically. 5. The art of relaxation can be learned, and relaxation helps us to avoid fatigue.	1. Air is a real substance and occupies space. 2. Air expands when heated. 3. Cooled air contracts and moves downward. 4. Heated air is moved upwards. 5. Wind is moving air. 6. Local winds are caused by unequal heating of the earth's surface. 7. Wind direction is indicated by a wind vane.
GRADE 4	1. Living things (plants) are produced by similar living things. 2. Some plants grow from seeds. 3. Seeds are produced by flowers. 4. Fruit develops from the flower. 5. Seeds are distributed by explosion, wind, water, and animals. 6. Some plants produce bulbs or tubers while lower plants such as molds, fungi, and ferns reproduce by spores. 7. New plants can be grown from leaves or stems of other plants. 8. Living things (animals) are produced by similar living things. 9. Many animals lay eggs, others bear living young. 10. Some animals feed and protect their growing young. 11. Some animals produce many young at a time. 12. Some simple (microscopic) animals reproduce by breaking apart.	1. Digestion is the process of breaking food down into smaller chemical parts so it can be used by the body. 2. Only complete digestion of food can give us the full benefits of what we eat. 3. The undigestible portion of food (cellulose) is necessary for the normal functioning of intestines. 4. Different parts of the digestive tract have quite different functions in the total process. 5. We are able to eat what we wish rather than choose foods of the same type because the entire digestive system functions whenever we eat. 6. Activity and emotions may have an adverse effect on digestion.	1. Water evaporates into invisible vapor. 2. When water vapor cools, it condenses into liquid. 3. Condensed water vapor falling to the ground is called precipitation. 4. Rain, snow, sleet, and hail are all forms of precipitation. 5. Some precipitation soaks into the ground while some runs off into streams, lakes, and oceans. 6. Excessive precipitation causes great damage by erosion and flood. 7. The process of continuous evaporation and condensation is called the water cycle.
GRADE 5	1. Animals require oxygen from the air, and they give off carbon dioxide. 2. Animals digest their food so that it can be absorbed and circulated to all parts of their bodies. 3. Animals are composed of cells. 4. The cells use food and oxygen to produce energy for growth and movement. 5. There are many different kinds of animal cells; nerve, muscle, blood, bone, and skin are the most common. 6. The smallest animals are composed of a single cell, while larger animals are composed of millions of cells. 7. Plants are composed of cells. 8. Green plants can produce their own food by the process of photosynthesis. 9. Green plants combine carbon dioxide with water to produce their food (sugar). 10. Sunlight provides the energy for the process of photosynthesis. 11. Green plants are the first link in any food chain.	1. A wound is any break in the skin. 2. The body has ways of controlling bleeding, but often it is best if we assist. 3. Bacteria are all around us and they can enter the body through any break in the skin. Cleanliness is very necessary to avoid infection in a wound. 4. Even a clean cloth may have bacteria on it. We should cover cuts with sterile cloth if possible. This allows no dirt or bacteria to enter the body. 5. Whenever a blood vessel is cut, bleeding will occur. The amount of bleeding depends on the number and size of the vessels cut.	1. Air is a mixture of oxygen and other gases. 2. Air takes up space and has weight. 3. Air exerts pressure. 4. A barometer measures air pressure. 5. Pressure in moving air is less than pressure in still air. 6. Air heats when it is compressed and cools when it expands. 7. The air surrounding the earth is called the atmosphere. 8. The three layers of the atmosphere are the troposphere, the stratosphere, and the ionosphere.
GRADE 6	1. Scientists have arranged plants and animals into similar groups in order to study them. 2. Classification of living things is based on their structure. 3. Classification emphasizes the development of simple forms of life into more complex forms. 4. Living things have developed into complex organisms very slowly during millions of years. 5. Many different kinds of plants and animals live together in nature and depend on each other for food.	1. To achieve physical fitness there is a need for strenuous physical activity. 2. Physical fitness helps us do most everything we try easier and better than when we are not physically fit. 3. Food, rest, and sleep are important helps in achieving physical fitness. 4. Physical fitness ultimately depends on how strong the heart muscle is because we depend on it for oxygen and food in the cells and for taking away waste products. 5. Increase in strength of all muscles, including the heart, depends on exercise.	1. The conditions of the atmosphere are measured by various weather instruments. 2. Atmospheric conditions vary from place to place and from time to time. 3. Low pressure areas are generally associated with stormy weather and high pressure areas are generally associated with fair weather. 4. The general movement of our daily weather across the country is from west to east. 5. The Weather Bureau predicts the weather from the measured conditions of the atmopshere. 6. The weather map shows the daily conditions of our atmosphere.

(WITH SUGGESTED GRADE PLACEMENTS)

IV. THE EARTH AND ITS COMPOSITION	V. THE SOLAR SYSTEM AND BEYOND	VI. MATTER AND ENERGY
1. Rocks are hard, nonliving things. 2. Rocks have various colors, sizes, and shapes. 3. Gravel and pebbles are small pieces of rock. 4. Some rocks feel rough and others feel smooth. 5. There are many kinds of rocks.	1. We live on the earth. 2. The earth is very large. 3. The sun gives us light and heat. 4. Light reflected from the moon helps us see at night.	1. Sounds are made by people, and animals, and moving objects. 2. Sounds travel in all directions. 3. We hear sounds with our ears. 4. Sounds may be pleasant or unpleasant. 5. Sounds can warn us of danger.
1. The land on which we live is made up of rock and soil. 2. Sand is broken bits of rock. 3. Soil is made of broken-down rock and decayed plant and animal material. 4. Stone is used as a building material. 5. Stone which is used to build things is strong and hard. 6. Stone is used in many ways around the house and in schools.	1. The earth is round. 2. There is air all around the earth. 3. The sun is much larger than the earth. 4. The four seasons of the earth are spring, summer, fall, and winter. 5. The moon is smaller than the earth. 6. Sometimes we see both the moon and the sun in the sky.	1. Light lets us see. 2. Shadows are made when light is blocked. 3. The sun, fire, and electric lamps produce light and heat. 4. Heat has many uses. 5. Fire may cause great damage.
1. Rocks are constantly being worn down or broken by wind, water, temperature changes, plants, and chemicals. 2. Different kinds of soil are formed from different kinds of rock. 3. Soil contains bits of broken rock and decaying plant and animal matter. 4. Most plants need soil which contains organic matter. 5. Soils differ in their ability to hold water. 6. Topsoil is a valuable resource and should be conserved.	1. The earth revolves around the sun. 2. The earth revolves around the sun once in our year. 3. The rotation of the earth causes day and night. 4. The change of seasons affects man, animals, and plants. 5. We can tell direction by the sun and stars. 6. The sun rises in the east and sets in the west. 7. The sun and stars are always shining. 8. The moon is the earth's nearest natural neighbor. 9. Stars vary in size, brightness, and in distance from us. 10. Stars look small because they are so far away.	1. Our world is made of many different kinds of matter (material). 2. Matter may be solid, liquid, or gas. 3. Solids have a definite volume and shape. 4. Liquids have a definite volume but take the shape of their containers. 5. Gases have no definite volume or shape. 6. Many materials are enough alike to be grouped into "families" such as metals, plastics, etc.
1. The surface of the earth is constantly changing. 2. Rocks can be broken apart by heat (sun), freezing, water, and plants. 3. Mountains and hills are being worn down. 4. Running water is largely responsible for the wearing-down process (erosion). 5. Earthquakes, volcanoes, and slower earth movements are constantly building up new mountains.	1. The sun is the center of our solar system. 2. The sun is composed of hot glowing gases. 3. There are nine known planets in the solar system. 4. The earth is one of these nine planets. 5. The nearly circular paths of the planets around the sun are called orbits. 6. The moon and planets shine only by reflected light. 7. The same side of the moon always faces the earth. 8. The apparent shape of the moon depends on the position of its sunlit surface that we can see. 9. There is no air or water on the moon.	1. Magnets attract things made of iron. 2. Magnets are strongest at their ends or poles. 3. Magnetic force can act through some materials. 4. Magnets repel as well as attract each other. 5. A compass can be used to determine direction. 6. A compass is a magnet which can turn easily.
1. Rocks are grouped as igneous, sedimentary, and metamorphic. 2. Igneous rocks form when magna or lava cools. 3. Sedimentary rocks are formed when sand or other sediment is compressed and converted into rock. 4. Metamorphic rocks are formed from other rocks which have been heated or squeezed into new forms. 5. Rocks are composed of minerals. 6. Three common rock-forming minerals are quartz, feldspar, and mica. 7. Fossils are evidence of life in the past and may be found in sedimentary rock. 8. A geologist is a scientist who studies the history of the earth and the rocks and minerals which make up the earth's surface..	1. Our temperature zones are caused by the tilt of the earth's axis. 2. The seasons are caused by the tilt of our axis and the position of the earth in its orbit. 3. The sun is an average-size star. 4. The planets shine by reflected sunlight. 5. The planets vary in size and distance from the sun. 6. The planets and their satellites are held in their orbits by gravity and inertia. 7. The moon rises at a different time each day. 8. The tides are caused by the gravitational pull of the sun and the moon.	1. Heat is a form of energy. 2. Heat energy is used to run many machines. 3. Heat is produced by fire, friction, and electricity. 4. Metals are good conductors of heat; wood is a poor heat conductor. 5. Heat from friction is wasted energy. 6. Friction makes it difficult to slide one object along another. 7. Friction is reduced by the use of bearings and lubrication. 8. Friction is useful in stopping moving things. 9. Machines are used to make work easier.
1. The interior of the earth is hot. 2. Geysers and hot springs bring dissolved minerals to the earth's surface. 3. Volcanoes, earthquakes, and geysers are earth-building forces. 4. Weathering and erosion wear down the surface of the earth. 5. Water, wind, chemical reactions, temperature changes, and plant growth slowly disintegrate rock. 6. Disintegrated rock is moved to lower areas by water, ice, and wind. 7. Topsoil is often lost faster than it is replaced. 8. Topsoil contains sand, silt, clay, and humus. 9. Soil conservation practices include crop rotation, terracing, and contour farming. 10. The ocean has been made salty by the dissolved minerals that streams have carried into it. 11. Limestone caves are formed by action of water as it seeps down through rocks. 12. The depletion of resources, including soil, changes the way we live.	1. The solar system is composed of the sun, planets, satellites, planetoids, meteors, and comets. 2. There are various theories describing the origin of our solar system and the universe. 3. The sun is a sphere of hot gases. 4. Disturbances (storms) on the sun's surface are called sunspots. 5. The volume of the sun is about 1 million times the the volume of the earth. 6. The planets rotate as they revolve. 7. Our sun is an average-size star. 8. Galaxies are huge collections of stars. Our galaxy is called the Milky Way. 9. The stars in our sky seem to revolve around the earth because of the earth's rotation. 10. Constellations are groups of stars which appear to outline a figure. 11. Different constellations come into view with the change in seasons.	1. Static electricity can be produced by friction. 2. Electricity can be generated by moving wires through a magnetic field of force. 3. Electricity from the generating plant comes into our homes through wires. 4. We change electrical energy into heat, light, magnetism, and sound for our use. 5. A switch is used to start and stop the flow of electricity in a circuit. 6. Some materials are electrical conductors and some are electrical insulators. 7. Fuses and circuit breakers protect our homes from electrical accidents.
1. Rocks are mixtures of minerals. 2. Minerals are naturally occurring inorganic substances and have a definite chemical composition. 3. Minerals have definite physical properties. 4. Minerals may be identified by color, hardness, and other characteristics. 5. Minerals that can be mined profitably are usually called ores. 6. Minerals are nonrenewable resources and should be used wisely.	1. Planets differ in physical characteristics such as size, motion, gravity, atmosphere, and temperature. 2. Forces man must consider when sending rockets into space are gravity, inertia, and friction. 3. Energy released from the sun is called solar radiation. 4. When the moon blocks the sunlight from the earth, a solar eclipse occurs. 5. When the earth blocks the sunlight from the moon, a lunar eclipse occurs. 6. The phases of the moon result from our viewing various amounts of the lighted side of the moon. 7. Our units of time are based on astronomical motions. 8. Astronomers use telescopes, spectroscopes, and cameras in their observations. 9. The great distances through space are often measured in light years. 10. Our knowledge of astronomy has developed as the result of the work of many scientists over many years. This knowledge is incomplete and always subject to questioning and change.	1. Matter is composed of very small particles called atoms. 2. Groups of atoms join together to form molecules. 3. A substance composed of only one kind of atom is called an element. 4. There are over 100 known elements. 5. Elements can combine to form compounds. 6. Chemical changes result in the formation of new substances. 7. The combustion of fuel is a chemical change which releases energy. 8. Physical changes do not result in the formation of new substances. 9. Matter may be solid, liquid, or gas depending on the behavior of its molecules. 10. Some atoms are radioactive and release energy. 11. Man has learned to use the energy released from radioactive materials, which is called nuclear energy.